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AND ABSTRACT OF THE LITERATURE

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PLACING CARDIAC PATIENTS IN REGULAR INDUSTRIES*

MRS. JOHN S. SHEPPARD

OF late years there has been a growing appreciation by physicians of the importance of work for persons with heart disease, and a realization of the therapeutic value, not only of the work, but of participation in a gainful occupation in regular industry.

TRADE SCHOOL FOR CARDIAC CONVALESCENTS

As a result of this feeling, and realizing the extent and importance of the problem of proper convalescence and employment for cardiac patients, the New York Conference on Hospital Social Service (now the Hospital Social Service Association) in April, 1912, appointed a committee to study the situation. This Committee made its report in November, 1912, and, on the presentation of the report the following suggestion was made: "That, inasmuch as cardiac cases need a protracted convalescence upon discharge from the hospital, this convalescent period of several months would provide an ideal opportunity for a study of the patient's capacity and adaptability, both physical and mental, and for the selection and teaching of a trade suitable both to his intelligence and to his physical handicap." This suggestion led to the establishment, in July, 1913, of a Convalescent Home for Cardiacs at Sharon, New York, and about two months later the industrial training of the men was undertaken. This training was in cement work, making flower pots, sun dials, fountains, and all sorts of garden furniture. When this enterprise was later incorporated it was under the name of the Trade School for Cardiac Convalescents.

A workshop was established in New York City in January, 1913, in which men who had been trained in the Convalescent Home at Sharon were employed. The conditions in the workshop were ideal in every way, and the men were under careful supervision, having a weekly medical examination. In practically every case the work had a beneficial effect upon the patient.

*Study made for the Sturges Research Fund of the Burke Foundation. Received for publication June 29, 1923.

Unfortunately, because of the war and the unsettled economic and social conditions resulting therefrom, the Trade School for Cardiac Convalescents was forced to close in 1916; but in spite of the premature ending of this interesting experiment, some definite conclusions may be reached and some significant inferences drawn which will be valuable in the solution of the problem of the cardiac patient in industry.

Conclusions and Inferences from this Experiment.—It was shown that there was a marked contrast between the progress of the early patients in the Convalescent Home before industrial training was established and that of the later patients who had the benefit of work as occupation. As was said in the first annual report of the work, "The patient gets a motive, a reason for forgetting himself, a future to look forward to and a ground for self-respect."

The experience of the Trade School seemed to indicate that in many cases patients do not require a long period of convalescence, but can begin suitable work after short convalescence and sometimes immediately after leaving the hospital. It was also shown that in suitable occupations, which do not unduly tax the limited powers of the patients, they can work under the piecework system without jeopardy to their health.

It was certainly demonstrated that cardiac patients have a greater work tolerance than they were at first thought to have.

The experiment did not last long enough either to prove or to disprove that a workshop of this kind could be self-supporting. It seems fair, however, to draw the inference that such a workshop never could be self-supporting, and that special workshops and factories of this kind cost too much in time, effort, and money for the small percentage of cardiac patients who cannot work in regular, carefully selected industries. This percentage seems to be growing smaller all the time, as industries are more carefully selected and the classification of the patient as to work tolerance, sent by the doctor to the placement worker, is more dependable.

Employment Bureau for the Handicapped

In 1918 the problem of employment for cardiac patients was again brought before the Hospital Social Service Association, but this time it was as part of the general problem of employment for all types of physically handicapped persons. In order to be of the greatest assistance to the hospital social service departments, the placement of all physically handicapped persons was undertaken in the Employment Bureau for the Handicapped which was opened in April, 1918, in the office of the Hospital Social Service Association at 405 Lexington Avenue, where the Bureau is still carrying on this work.

Although in this paper only the placing of cardiac patients in industry will be discussed in detail, attention should be called to the fact that a large general employment bureau for handicapped persons can do better placement work for special groups than smaller bureaus dealing exclusively with those special groups. There are several reasons for this. The larger the number and the more diversified the group of applicants for work, the more chance the employer has of finding the person that he wants for the job and consequently the more frequently he will apply to that employment bureau for workers. Also, the larger the number and the more diversified the industries with which the place-

ment worker is in touch, the more kinds of work she can try out and the more new openings she finds for work which may be well adapted to special types of handicaps. The work becomes better known to employers in general, and the enlarged field of industries makes better placements possible.

Record Forms.—All applicants to the Employment Bureau for the Handicapped are required to bring a card, such as that shown in Figure 1, properly filled out; otherwise they are not accepted for placement. After an applicant is accepted, the history card shown in Figure 2 is made out and kept on file. On the back of this card is kept the placement record of the patient.

FIGURE 1.—APPLICATION CARD

HOSPITAL SOCIAL SERVICE ASSOCIATION OF NEW YORK CITY

EMPLOYMENT BUREAU FOR HANDICAPPED

Room 515 405 LEXINGTON AVENUE, NEW YORK CITY Tel., Vanderbilt 5240

Referred by ..... Worker ..... Date.....

Name ..... Age.....

Address .....

Handicap: Nature and extent

.....

Kinds of work recommended.....

Remarks .....

.....

.....

THIS CARD MUST BE SENT WITH THE APPLICANT—Office Hours 9-5 Daily

Number of Handicapped Persons Placed.—From the establishment of the Employment Bureau for the Handicapped in April, 1918, up to November 1, 1922, 5,304 persons have been placed. Of this number 1,039 were cardiac patients. To put this number of handicapped persons into regular industry is a valuable contribution to the community; and the fact that the wages of handicapped persons placed by the Bureau in one month amounted to $11,657.60, while the cost of running the Bureau for that same month was less than $500, shows that the work is distinctly valuable on the financial side as well as on the broader basis of value to the man himself in assisting him to become self-supporting and to take his place again in the life of the community.

Fees.—It is not advisable to charge fees for placement as a commercial bureau does, for most of these applicants would never come to the Bureau unless the service were free to them. Most physically handicapped persons have lost the desire to work, and one of the most important functions of an employment bureau for the handicapped is to persuade them to try. They never would come to a bureau and pay for being persuaded to try to work.

An employer cannot be asked to pay a fee for giving him men who are physically handicapped, when he is very doubtful of their usefulness to him and fears that they may lower his standard of production instead of increasing it.

The value in the labor of persons who are handicapped must be demonstrated to employers and, when this can be done, an element is added to the productive force of the community which has hitherto been practically unused.

Another reason why it is doubtful whether any commercial bureau would ever find that it paid to do this work efficiently, is that employment for handicapped persons must be selected with expert care, and placements take so much time that it would not pay as a commercial enterprise.

For all these reasons given above, it is probable that this sort of work must always be supported by voluntary contributions from people who appreciate its value, or it must be subsidized by the state.

Cost.—For 1922 the cost of each placement made by the Employment Bureau for the Handicapped was $3.31. This shows that the cost of this work will never be a great burden on the community; and in comparison with the cost of establishing and carrying on special industries for the handicapped, the cost of maintaining an employment bureau seems to be negligible.

Problem of the Cardiac Patient

After plans were outlined for the establishment of the Employment Bureau for the Handicapped, a survey was made of industries which it was thought would be suitable for handicapped persons. The first list of such industries was drawn up in consultation with the industrial experts of some of the life insurance companies. The factories and places of work, to which patients were to be sent in those industries, were carefully examined and the co-operation of the employers was enlisted.

Special emphasis was laid on the problem of suitable work for cardiac patients, as being one of the most difficult and important with which the Employment Bureau would have to deal, and also because the result of overstrain by work would be more disastrous to the cardiac patient than to other types of handicapped persons.

Some idea of the magnitude of the problem can be obtained from the estimate that there are over two million people with heart disease in the United States. Even more illuminating for the purposes of our undertaking, is the fact that during the war 42.3 men out of every thousand were rejected by draft boards and army surgeons because they had heart disease. These men were all from the age group from which we expect the greatest work output, and their inability to take their places in industry is a great economic loss.

These figures of the draft, which show over 4 per cent. of cardiac patients in this large group, taken in connection with the fact that there is a definite increase in the incidence of heart disease with age, throw doubt on the usual estimate of 2 per cent. of cardiac patients in the population. While no definite figures are available, it seems certain that 2 per cent. is decidedly an understatement of the situation.

There are difficulties to be overcome in the proper placing in industry of all types of handicapped persons, but there are especial difficulties in the case of the applicant with heart disease.

The functional disturbance with heart disease is very great and induces a nervous condition which makes the patient restless and less contented with his job than other handicapped workers. As Dr. Brush found in his study of cardiac patients, there is a "marked disinclination to exercise, amounting frequently to fear or obsession. This attitude fo-

lows the customary composite of physical prohibitions (don'ts and can'ts) as fostered by physicians, hospitals, schools and parents.''

Usually the patient who comes to the Bureau to be placed has had a long illness and has lost the habit of work, which adds another obstacle in the way of his placement. Also the term ''heart disease'' and the name ''cardiac'' seem to inspire such terror in some patients that they are constantly in fear of sudden death. The apprehensive attitude of friends and relatives of the patient, who constantly shield him from all exertion, is another factor in making him neurasthenic and in fostering the development of unfounded fears.

These are some of the difficulties which come from the attitude of the patient himself and which must be overcome by the placement worker.

Co-operation of Hospital Social Service Departments.—The difficulties of the placement worker can be lessened by the active co-operation of the hospital social service worker who refers the patient to the Bureau. This effective co-operation is to see that a dependable classification as to work tolerance is always sent with the patient, and that the patient is instructed as to the importance of taking work suited to his handicap and is warned of the dangers of relapse if he does not do this. He must be persuaded of the wisdom, in the long run, of accepting work which he can do without injury to his health, even if it means taking lower wages than he has been receiving. The necessity of reporting regularly at the clinic in order that the effect of work on his physical condition may be watched, must also be impressed upon him.

He must also be instructed as to the great importance of reporting for work

FIGURE 2.—HISTORY CARD

HOSPITAL SOCIAL SERVICE ASSOCIATION OF NEW YORK CITY

EMPLOYMENT BUREAU FOR THE HANDICAPPED

Referred by .....Worker..... Date .....
Name .....Age.....M.S.W. Children....
Address .....
Nationality .....Religion .....
Handicap: Nature and extent.....
Previous medical treatment and where.....
Employment: Duration previous to handicap.....Wages.....
Duration since handicap.....Wages.....
Attitude toward work.....
Aid received by patient: From whom and how long?.....
.....
Remarks: .....
.....
.....
.....

when he has accepted a position and promised to commence work at a definite time. This matter of not reporting for positions is one of the greatest obstacles against which we have to contend, and the social service worker can be of more help than anyone else in making the patient realize that it not only hurts his chance of getting another job, but that it closes many factories and shops to the handicapped worker, because the employer will not continue to patronize an employment bureau from which the workers do not report for work at the time agreed upon.

Co-operation of Physicians.—The difficulties which come from an apparent lack of understanding by physicians of the importance of their co-operation with the Bureau, are steadily growing fewer, but there is still room for improvement along this line. A dependable classification as to work tolerance must be sent with the patient, and there should be the assurance that this classification means the same from all clinics. It is also a help to the placement worker to have the physician send all data which he may have bearing upon the ability of the patient to work.

Classification of Cardiac Patients

The classification used is that of the Association for the Prevention and Relief of Heart Disease, but apparently there is a great difference as to the tests by which patients are thus classified. We realize, of course, that all cardiac patients are individual problems and that it is therefore almost impossible to make rigid classifications and rigid rules; but in general we feel that if the classification were based on the test of going upstairs, 30 feet in forty seconds, it would enhance its dependability as to the work tolerance of the patient.

Under these classifications of the Association for the Prevention and Relief of Heart Disease, we find the situation as follows:

Class I.—Organic (able to carry on habitual physical activity). There is almost no problem as the patient can do practically anything, but he should return to the clinic for examination every three months.

Class II.—Organic (able to carry on).

A. (Slightly diminished physical activity.) These patients need selected industries and in most cases they should report to the clinic once a month so that the effect of the work may be watched.

B. (Greatly diminished physical activity.) These patients constitute the great problem, and in this class, more than in any of the others, is the need felt for some sort of standard test upon which to base the classification. A Class II B patient may, with proper placement, be a potential II A, or he may deteriorate rapidly into Class III from causes entirely unrelated to his employment. All such patients need very carefully selected industries and should report to the clinic, at first at least every two weeks, and later every month, in order that the effect of the work may be observed.

Class III.—Organic (unequal to any physical activity). These patients are sometimes able to work. Several patients in this class, placed by the Bureau, have worked for as long a time as three years. In accepting these patients for placement, however, an employment bureau must guard against the risk of hurting its relations with employers because of the hazard of sudden death. In every case of this kind the employer must have a full explanation of the danger inherent in the situation.

The records of the Employment Bureau for the Handicapped, however,

show only two cases of sudden deaths of patients while at work. One was a man, 55 years of age, who was employed as a watchman on the pier of a steamship company. The card sent by the physician with this applicant (this was in 1920 before the present classification of cardiacs was in use) stated that he had been a cardiac for six years and that his heart was well compensated. In this case it hardly seems as if the cause of his sudden death could have been related to his work. The second case was that of an elderly man, doing clerical work.

Class IV.—"Possible" heart disease. (Doubtful murmurs; mainly accidental, possibly organic.) These patients are not a real problem, but should have careful placement.

Class V.—Potential (predisposing history). These patients constitute practically the same problem with regard to placement, as do patients in Class IV.

Cases of auricular fibrillation may be accepted for placement, if, when fully digitalized, they are in Class II A, possibly in some instances even in Class II B. The importance of regular attendance at the clinic, at least every two weeks, must be impressed upon these patients.

Conditions of Occupation

The occupation in which the cardiac patient is placed should demand less physical exertion than he is able to give, never the maximum amount, so that there will always be a margin of potential strength left.

Any change which must be made in the occupation of the cardiac patient should be, if possible, to work allied to his former employment. This is a large factor in overcoming the discouragement of the patient when he has to give up his old job on account of his handicap.

Noise and dust are no worse for cardiac patients than for other nervous persons, but any conditions which are detrimental to the general health of workers should, of course, be avoided for cardiac patients.

Patients in Class II A can work eight hours standing, but must not have too severe strain in work.

Those in Class II B should have employment near home because a long trip to and from work adds too much strain. They should not have to climb stairs, and stooping and lifting should be eliminated. They can work eight hours sitting, but it is best not to have them try to work for eight hours where standing is continuous.

In all cases with complicating rheumatic infections, work must not be in a damp place.

The greatest problem that the placement worker has is to find suitable employment for cardiacs in Class II B, but every year of experience shows more fully that the lives of very few patients in this class are ever shortened by work. There is much greater danger to them from infection than from exercise. Many physicians are too timid about prescribing or allowing work for their patients in this class.

Testing New Industries

New industries in which cardiac patients are to be placed should be carefully examined as to stairs to be climbed, dampness, distance from home, whether there is much lifting or stooping required in the work, and whether the work can be done while sitting or whether it requires constant standing.

As far as possible work should be

chosen in which the régime is not too rigid. If the worker can stop from time to time and rest for a few moments, it is a great help, especially in Class II B cases. This seems to indicate that piece-work is good for patients if they will use judgment and not push themselves too much.

Figures 3 and 4 show the card used in examining conditions in new industries as to their suitability for the employment of handicapped workers.

The only practical and conclusive test of the suitability of new industries is trial by work and closely following the effect of the work on the patient. Class II A patients should report to the clinic every two weeks for observation when trying work in new industries. Class II B patients should report every week until it seems certain that their condition is not deteriorating under the work. Class III patients need not be discussed in this regard as new industries should never be tried out with them.

FIGURE 3.—FRONT OF CARD USED IN SURVEY OF NEW INDUSTRIES

Industry — Special process (If any)

Name — Address — Phone — Floor

Department — No. Employed — Men — Women

Occupation	Number: Men	Number: Women	Hours: Day	Hours: Week	Hours: Overtime	Weekly Pay	*Process*: H—hand	*Process*: M—machine	*Position*: S—seated	*Position*: St—standing	*Position*: M—moving	*Nature of Work*: P—piece	*Nature of Work*: W—week	*Nature of Work*: S—seasoned	*Nature of Work*: Sk—skilled	Conditions*

Conditions*: F—fumes M—moisture Fa—fatigue P—poison HC—constant heat TC—temperature changes (indicate—extreme, considerable or moderate) Dust—state kind, quantity, dry or wet process

Employment Mgr. Mr. — Person Interviewed Mr.

Union Facts — Use of Elevator

Date of Inspection — Investigator

*Always indicate whether hazards are controlled; *i.e.*, by hoods, suction apparatus, vents, natural ventilation or precautions.

Employers

In general employers are very co-operative, but the labor conditions since

the establishment of the Employment Bureau for the Handicapped have been so fluctuating that no absolutely definite conclusions as to the difficulties of this side of the problem can be reached. For the first three years of the work of the Bureau there was so great a shortage of labor that it was very easy to find work conditions in 1921 when it was especially difficult to find work, the Bureau placed 1,128 out of 8,398 applicants, and in 1922, placed 1,717 out of 4,789 applicants, shows that this work can go on with an encouraging measure of success, even in times of work shortage.

The employer should not be asked to

FIGURE 4.—BACK OF CARD USED IN SURVEY OF NEW INDUSTRIES

Attitude towards workers — Retention of workers

Type of workers

Care of workers: Health instruction — Health placards — Medical supervision

Washing facilities — Rest periods

Sanitary conditions of plant

Additional Facts Regarding Occupations
(Give detailed description of work if considered necessary)

for handicapped persons and all employers were glad to take them, even for part time where that was thought, by the placement worker, to be demanded by the nature of their handicap. Since that time there has been a shortage of work and it has been difficult even for normal persons to find employment and therefore especially difficult for the handicapped. That, in spite of these

take patients as a charity, but industries must be selected in which cardiac patients can give full labor value for full wage. Only in this way can the work ever be put on a stable foundation. If cardiac patients cannot be put in regular industries on equal terms with normal workers, but can be so placed only when the employer is willing to make concessions and take them as charity, we

should face this fact squarely at once. Special concessions should never be asked of the employer if this experiment is to be tried out fairly.

Moreover, the employer must not be annoyed by having the handicapped worker followed-up while he is at work. In the factory or shop the handicapped man must take his place as other employees do and the follow-up work must be done at the clinics or through the home.

Employer's Liability.—The Workmen's Compensation Law provides compensation for "accidental injuries arising out of and in the course of employment." This, of course, gives compensation in the case of death or incapacity resulting from an accident, but an accident which would not seriously incapacitate or cause the death of a well man might do so in the case of a man with heart disease; that is the reason why some employers have not wished to employ cardiac patients.

The suggestion is often made that a cardiac should sign an agreement with his employer, holding him harmless under the Workmen's Compensation Law, but this cannot be done because Section 32 of the Act provides that, "No agreement by an employee to waive his right to compensation under this chapter shall be valid."

The experience of the Employment Bureau for the Handicapped has been that very few employers are afraid to take men with heart disease, and that the possibility of more accidents with them than with normal men has not proved to be at all a formidable obstacle to the placement of cardiac patients in industry. We have had no complaint from employers about trouble under the Workmen's Compensation Act with patients placed by this Bureau.

Factors in Successful Placement of the Handicapped

Personality of Placement Worker.—The personality of the placement worker will always be a great factor in the success of this work. She must have judgment and intelligence in selecting suitable employment for the patient, and must have a kindly and sympathetic understanding of his abnormal point of view. She must also have tact and perseverance in persuading him to take work which will restore him to a normal life. For the last three years this Bureau has been particularly fortunate in having a director who has all these qualities, and this has been one of the largest factors in its success.

Follow-Up.—A very important feature of the work of an Employment Bureau for the Handicapped is to follow-up the patients who have been placed. This is not only necessary for the good of the patients, but for the progress of the work of the Bureau in enlarging the number of industries which are suitable for cardiac patients, by seeing that the condition of the patient does not deteriorate under the work.

In theory many industries are suitable for cardiac patients, but in practice it is often found that there are features of the work which make it entirely unsuitable. An example of this is the work of opening oysters, which promised to be excellent for some cardiac patients, until it was found that the man who opened the oysters was also required to carry heavy baskets of oysters and oyster shells back and forth, and this was far too heavy a strain for him to bear. Without careful follow-up a man placed in this position might have been seriously injured.

The experience of the Employment Bureau for the Handicapped has been

that the only feasible way to have good follow-up work done is through the social service departments of the hospitals and clinics that refer the patients to the Bureau for employment.

The plan of having the follow-up done by a worker from the Employment Bureau has been tried and found to be unsatisfactory, as it means in many ways a duplication of the work already done by the social service worker, such as taking the social history of the patient, keeping track of his return to the clinic and watching carefully his home conditions. All this is done by the social service worker, and it is annoying to a patient to have to go all over the same ground again with another person. Even after a worker from the Employment Bureau has gathered all this information she may have omitted important factors in the situation which the physician and the social service worker already know, such as habits, temperament, reaction to treatment, etc.

Close Connection with Hospital Social Service Departments.—Close co-operation with hospitals, clinics and social service departments is a factor in the successful placing of cardiac patients in industry, and for this reason it is felt that it is a great help to the Employment Bureau for the Handicapped to be a part of the Hospital Social Service Association, to which practically all the hospital social service departments in New York City belong. This gives the Bureau an official standing and an easy approach to the hospitals and clinics, which is invaluable.

This consideration and the importance of having the follow-up by the hospital social service worker, indicate that employment bureaus for the handicapped should be closely affiliated with the social service departments of the hospitals and clinics.

Location of Employment Bureau.—The office of an employment bureau for the handicapped should be in a central situation and in a business building rather than in a hospital or in a building devoted exclusively to philanthropic purposes, as the ordinary business surroundings create a normal, work-a-day atmosphere which helps to remove the patient from the handicapped point of view.

Effect on Cardiac Patients of Regular Work

As the result of placements made by the Bureau since its establishment, we feel justified in saying that the effect of regular work on the condition of the cardiac patient is excellent, and that his work tolerance is much greater than it was thought to be before these placements in regular industries were made.

In 1920, intensive work was done by the Bureau in keeping track of 123 cardiac patients placed in regular industries. At the end of six months, the condition of ninety had improved, the condition of thirty had remained stationary, two had been lost sight of, and the condition of only one had deteriorated.

A study was made of sixty-nine of the Burke Foundation's discharged heart patients (men) representing both good and fair convalescents, who were placed in positions by the Employment Bureau for the Handicapped. "Of these, sixty-four were newly and well placed, one was returned to his former job and another to his western home, one was too young to obtain working papers, while two were considered too ill for placement when they came to make application for work. At the end of the year fifty-nine held their position, the majority being in improved health and contentment, ten had been back in

hospitals with heart attacks for short periods, fourteen others had heart treatments as outpatients, and one elderly man died suddenly while at clerical work. Fifty-five were still co-operative with their Cardiac Clinics. This group was considerably below the average of discharged patients in physical and economic fitness, some of them not having previously worked for months or years.'"[1]

Experience has also justified the statement that well-selected work will frequently help cardiac patients to improve and to go from Class II B to II A. Work in normal surroundings has a much better effect than work in segregation.

Conclusion

If this discussion of the problem of the cardiac patient in industry seems to err on the side of being too optimistic, perhaps more so than can yet be justified even by the encouraging experience of the Employment Bureau for the Handicapped, it must certainly be admitted that every step taken in the last few years in restoring the cardiac patients to a normal way of living has been more than justified by the results, and that cardiac patients have been shown to have a much greater work tolerance than was before this believed.

While we cannot look forward to having 100 per cent. success in placing persons with heart disease in regular industries, we can certainly hope to diminish steadily the percentage of those who are considered now to be unplaceable.

The very momentum of this work itself will remove some of the obstacles to its success, for, admittedly, much of the trouble with cardiac patients is their bad mental attitude and their neurasthenia. As cardiac patients in larger and larger numbers are shown to be able to take their places in regular industries, the attitude of both the cardiac patient and the public will change to a more hopeful and helpful point of view. It must always be kept in mind, however, that those industries must be carefully and expertly selected.

The following is a list of occupations and industries prepared by Mrs. Ida M. Duggan, Director of the Employment Bureau for the Handicapped.

Industries and Occupations in Which Cardiac Patients Have Been Successfully Placed According to Cardiac Classifications

	Class
Architects	
Draughtsman.—High school education, with a good knowledge of drawing. Started as juniors making minor blue prints from specifications, under supervision.	I-IIA
Filing blue prints.—High school education. Blue prints filed according to plans and specifications.	
Estimating plans.—High school education. Estimating cost of construction, including materials, labor, etc.	
Automobiles	
Assembling batteries.—Putting in wires, fluid and attachments. Some lifting entailed.	I-IIA
Assembling and construction.—Small units, steering gear, brakes, batteries, tinsmith work; later put on larger units. Requirements:—Handy with tools, anxious to learn trade. Work light. No age limit.	" "
Supplies' clerk.—Good penmanship, slight amount of clerical work. Has full charge of all tools and supplies used throughout factory. Checks distribution of tools and orders new stock. Elderly men.	I-IIB
Salesman.—High type. Previous experience.	I only
Service station door-man.—Checks incoming and outgoing cars. Elderly men.	I-IIB

[1]Brush, F.: The Convalescent Treatment of Heart Disease by Exercise Applied through Natural Work and Play Methods.

Bakeries and Biscuit Companies

Packing.—Bread, crackers, cakes, etc. Hand work. I-IIB

Wrapping.—Bread, crackers, cakes, etc. Machine work.

Labeling.—Bread boxes and packages. Hand work.

Icing.—Bread, cookies and fancy cakes. Machine work.

Requirements:—Able to stand most of the time. Young women. Light work.

Cans

Tinsmith's helper.—Prepares materials for tinsmith. Operates small can-making machine. I-IIB

Soldering.—Tops of cans, using acetylene torch.

Labeling and pasting.—Names of manufacturers using product. Not suitable for neurasthenic type, on account of danger from burns from solder, or catching fingers in machine. Very light work.

Clothing (Men's)

Machine operators	I-IIA
Hand-finishers	I-IIB
Buttonhole makers	I-IIB

On men's suits and overcoats. In most cases these industries are controlled by the union.

(Women's)

Machine operators	I-IIA
Hand-finishers	I-IIB
Embroiderers	" "
Beaders	" "
Buttonhole makers	" "
Drapers	" "

On women's cloaks, suits, dresses, and waists. In most cases controlled by the union.

Must join union in large percentage of industries.

Detectives and Watchmen

Construction.—Located at entrance to prevent people from entering, on account of danger. Can sit most of time. Days. I-IIB

Government.—Government property —Governor's Island, and Ellis Island. Days.

Steamships.—On piers and boats in port to prevent stealing by employees. Also on coastline steamers. Days and nights.

Private houses.—Employed by individuals for their own homes, and by several families whose houses are grouped together. Days and nights.

Hotels.—On the different floors, the roof-garden, and at rear entrances to prevent trespassing and disturbances. Nights.

Department stores.—Inside of building. Outside of building to protect windows, etc. Days and nights.

Theatres.—At doors, in the audience, also in the rear of the stage. The duties of these watchmen are to watch very closely for fires and disturbances. Days and nights.

Banks.—Permanent for full time, days and nights. Also permanent for Sundays and holidays only. Make hourly rounds, throughout the building.

Industries.—At gates and doorways, and throughout the building making hourly rounds. Days and nights.

Elderly men preferred. Banks, department stores, and some other industries require physical examination by their own physicians.

Sedentary: construction, government, steamships, theatres. Make rounds at regular intervals: banks, private houses, hotels, department stores, and industries.

Dolls

Sewing.—Hand and machine work. In industries, and at home. Dresses, etc. Female. I-IIB

Dressing.—In industries and at home. Female.

Painting faces.—Hand spray. Male.

Inserting eyes.—Hand work. Male.

Operating machine.—Filling bodies with sawdust. Male.

Packing.—Dolls in boxes. Female.

Elderly men started as beginners, learn these trades. Sedentary.

Electric

Draughtsman.—Drawing plans for electrical appliances from preliminary blue prints. Started as apprentice, 18 to 25 years. High type. I-IIA

Mechanical engineer.—Designs, and supervises entire electrical equipment installation, motive power, regulations.

Must have thorough knowledge of electrical engineering.

Installation.—Installing electrical instruments, signal systems, telegraph and telephone motors. Entails lifting.

Requirements: High school education at least 2 years. Is given college course in connection with work by certain firms, to become electrical expert. Medical examination. Splendid type.

Farm Work

Assistant to gardener.—Very beneficial to applicant. Mowing grass, pulling weeds, trimming hedges, planting shrubs. I-IIA

Fruit picking.—Berries, peaches, apples, etc. The two latter entail some heavy work, as men must climb ladder and carry fruit in bags.

Milking cows.—In dairies. By hand and electric machine.

Driving horses.—In farm work and to town for supplies.

Fountain Pens (Men up to 30 years of age to learn trade.) I-IIB

Rubber department:

Operators.—Small lathe — boring holes in rubber.

Shaping and polishing.—With small buffer.

Pens.: Learning pen business. There are 22 different operations before the pen is complete.

Operating. — Small foot press (pushed with foot) for stamping, piercing, notching, inserting, slitting and numbering. The dies are set in the press for this process and pens are placed individually for the different operations.

Grinding.—With small hand machine.

Polishing.—With small buffer.

Furs

Machine operator.—Very difficult work. Takes long apprenticeship. Must join union in majority of positions. I-IIA

Dresser.—Preparing skins for the manufacturer.

Unsuitable for cardiac patients if condition is irritated by dust.

Grocers

Clerical.—Dictaphone operator; comptometer operator. I-IIB

Packer, stock clerk, order clerk, telephone.

Salesman.

Driver.

Hotels

Door-man.—At entrance, to open doors of carriages, and direct guests to different departments. I-IIB

Checker.—Food, in restaurant. Checks food as it leaves the kitchen. Is held responsible if incorrect. Prevents dishonesty of waiters. " "

Elevator operator.—Passenger and service cars. Young men for passenger cars. Elderly men for service cars, which carry employees and restaurant orders. " "

Silver-men.—Flat silver. Operate small washing machine. Count and sort. Keep record of amount. " "

Pantry-work.—Giving out supplies. " "

Seamstress.—Hand and machine. On curtains, upholstery covers, darning linens and curtains. No age limit if experienced. Position gives maintenance. " "

Clerical. — Auditing department, front office, mail department, restaurant, and on the different floors. " "

Assistant to engineer.—Takes orders for leaks, breaks, defective locks. In charge of workmen throughout the hotel. Types records. I-IIA

Painter and polisher.—Assigned to certain floors for rooms and halls. " "

Telephone operator.—Switchboards. Six months' experience in central office. Hours regulated by telephone company. I-IIB

Time-keeper.—At desk in rear entrance. Keeps complete time record of all employees, by which salaries are regulated. Receives all incoming messengers, etc. " "

Open to applicants of all ages.

Requirements: Must have unusually good references, as they have access to other parts of the hotel.

Jewelry (Young men about 17 years old as apprentices; public school education required.) I-IIB

Errand and office boy.—During the first year.

Bench work.—During the second year.

Designing.—Must be able to do drawing and desire to take up this line.

Cutting and setting.—Diamonds. Hand work. (Long apprenticeship before doing this work, as material is so valuable that the smallest waste means great loss to the firm.)

Setting.—Stones. Inexpensive material. Machine work. Done by apprentices very quickly as material is not valuable. Loss is small if imperfectly set.

Soldering.—Joining parts of brooches, etc., by use of small electric soldering iron. Hand work.

Filing.

Matching.—Pearls; by color and size.

Stringing. — Pearls. Are taught stringing and, when accustomed to this, are taught to become experts in the matching of pearls.

Repairing watches.

Laces

Darner.—Fine laces. I-IIB

Sample maker.—For display rooms and salesmen.

Trimmer and maker.—Curtains, waists, neckwear. Female.

Lamp Shades

Hand sewing.—Good hand sewers; I-IIB covering frames.

Framemaking and covering.—Bending and joining wires according to instructions.

Bead stringing.—For ornamentation.

Stock clerk.—Giving out and recording supplies to workers.

Pasting.—Paper lamp shades.

Painting.—Designs (stencils) on paper lamp shades.

Female.

Requirements: First-class hand sewers for covering and ornamentation. Are taught the trade in other lines.

Leather Goods (Bags and Belts) I-IIA

Apprentices begin as:

Paster.—Corners, linings.

Trimmer.—Threads, when machine stitching is finished.

Fitter.—Inserting mirrors, etc.

Operator.—Power machine—linings. Power machine—leather.

Mechanical Dentistry (Apprentices) I

Cleaning.—Utensils and apparatus used by mechanical dentist.

Mixing.—Plaster and pouring impressions.

Polishing.—Plates. Hold plate against surface of small electric polishing machine.

Vulcanizing. — In steam chest (steamtight) inside which heat is 320°. Process about 1½ hours. (Surrounding atmosphere is not heated.)

Gold work.—Use blow pipe. Old fashioned mouth blow pipe scarcely ever used. Foot bellows controlled by foot treadle.

Male. Young men up to 35 years of age. Work very light.

Motion Pictures

Inspecting reels. — Runs films I-IIB through projector to inspect for oil and grit, tears, and broken sprocket-holes.

Cleaning and repairing.—Cleans film when oily or otherwise dirty. Inserts new leaders when necessary.

Re-winding.—When in good order, reels are re-wound for future use.

Packing.—In cans especially constructed for this purpose. When for export, in tin-lined cans.

Operator.—Motion picture machine. I-IIA Must be licensed.

Checking.—Checks story (as shown I-IIB through the projector) when thrown on the screen, with the scenario.

Male. Elderly men preferred, because young men become restless and give up positions. Very light work. Mostly sedentary.

Pencils

Operator.—Dipping machine. Dips I-IIB pencils into varnish.

Inserting.—Rubber in ends of pencils. Machine, which inserts several dozens at once.

Counter.

Packer.—In boxes.

Stock clerk.—Records incoming and outgoing stock.

Male. Very light work. Standing and sitting. Unsuitable for many cardiacs on account of the odor of varnish.

Piano Factories

Assembling.—Piano actions. Hand I-IIB and machine work.

Gluing.—Felt on wooden hammers. I-IIB Hand work.

Operator.—Machine making ham- I-IIB mers and small wooden blocks.

Pinning and nipping.—Center nickel " " wires. Hand work.

Polishing.—Keys. " "

Male. Very light sedentary work. Taught trade. No age limit.

Publishers

Addresser.—Envelopes. Hand work. I-IIB Steady work or by the thousand.

Folder and inserter.—Letters, forms, " " circulars, pamphlets, magazines. Hand work. Steady or by the thousand.

Printer. — Press-feeders, straighteners, typesetters, fly-boys. I-IIA

Book-binding.—Books and magazines.

Paper gatherers—Sheets. Hand work. (Arranging pages in sequence when taken from the press.) " "

Folding machine operators. Sheets (after gathered).

Sewing sheets together.

Pasting on covers.

Bundler.—Magazines. For shipment, parcel post. " "

Requirements: Must join union after employed as printers, etc.

Sign Painting and Display Work

Department stores. — Cardboard, wood and glass, for sales, advertising, etc. I-IIB

Advertising agencies.—On a large scale for theatres, advertising, etc. " "

Commercial art.—Calendars, boxes, posters, designing carpets, wall paper, fabrics, etc. " "

Regular training required, covering 6 months' course. No age limit.

Steamships

Checker.—Cargoes of incoming and outgoing ships. Wagons and contents coming to and leaving piers. I-IIB

Special officer.—On piers and coastline boats. Act as watchman and detective. Prevent theft. I-IIA

Tobacco

Stripper.—Tobacco leaf. Sedentary hand work. I-IIB

Machine operator.—Making and cutting cigarettes. Small machine. " "

Packer.—In boxes. Machine work.

Male. Sedentary. Unsuitable for many cardiacs on account of odor of tobacco.

Trunks

Lining and pasting.—Trays and drawers, with paper or other material. I-IIB

Assembling.—Trays and drawers. Gluing small parts. Putting on handles. " "

No age limit. Sedentary. Very light work.

Wire (Baskets and brushes, and other small wire objects)

Cutting.—Wires in desired lengths. I-IIB

Operating.—Small production machine. " "

Framer.—Baskets. " "

Painter. — Baskets, bird cages, brushes, and other products. " "

Requirements: Must stand most of the time. Elderly men can learn this trade, standing part of time.

WEBER'S LAW, TOLERANCE, AND VISUAL JUDGMENT OF SIZE IN THE BOTTLE MAKING INDUSTRY*

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Introduction

TOLERANCE, or the allowable deviation from the standard size set for a container or other commodity, may be determined by the United States Bureau of Standards or by a state bureau of weights and measures. The specifications are usually determined upon in consultation with the managers of the various industries concerned. The final allowable variation, that is the tolerance, above and below this standard is partly determined by the refinement of methods and of workmanship possible in the particular industry. The matter of setting standards and of limiting the variations from them, in size of containers particularly, is of vast importance to the consumer. In the bottle making industry, with which we are particularly concerned in this paper, the tolerances allowed are specified in the handbook of the United Glassworkers of Canada and America. These tolerances were determined empirically after experience of many years in the industry, and indicate the variations from standard size that must be allowed in order to include the worker's average product. For example, it has been found that in making a 32-ounce bottle a range of 2 ounces below and 3 ounces above the specified weight must be allowed in order that the workers may come within these limits. In general the tolerances allowed in the bottle making industry follow Weber's law—that is, the tolerance is usually the same percentage of the specified weight. Weber's law, which applies to a great many physiological phenomena, states that in order to produce a noticeable change in sensation the same proportion of the stimulus must be added or deducted, whether the stimulus be large or small (see Luciani (1, p. 9)). Thus, to cite an example, if one were to lift six weights of 10, 10.5, 11, 100, 105, and 110 grams, and if the 10.5-gram weight did not, but the 11-gram weight did, seem heavier than the 10-gram weight, it would follow that the 105-gram weight would not, but the 110-gram weight would, seem heavier than the 100-gram weight.

Tolerances in the Glass Industry

In Figure 1, the allowable deviations from the standard weight are shown for bottles of different weights. In general it can be seen that the tolerances below the specified weight are less than the tolerances above, and that for bottles weighing from 10 ounces to 50 ounces the percentage tolerance allowed is approximately the same—namely, from 5 to 9 per cent. Below 10 ounces, however, the tolerance allowed goes up very rapidly. It is true also of Weber's law that it holds only through a certain limited range.

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Visual Judgment of Amount of Glass Gathered by Glass Workers

In order to understand how the amount of glass gathered in making bottles of various weights is judged by workers, some knowledge of the process is necessary. The glass is gathered by means of an implement called a punty, which consists of an iron rod with a wooden handle at one end and a clay ball at the other. This rod is held in the hand of the gatherer, who rests it on an iron support with the clay ball on the surface of the molten glass. The punty is rotated until a "gob" of glass rolls up on the punty head, or clay ball. The gob is then transferred and suspended over a mold into which the glass drips. In some types of machine another worker sits at the mold and clips the stream of molten glass. In the Lynch machine, however, the whole operation is carried on by the gatherer, and no clipping takes place. It was at first supposed that the workers judged the size of the gob of glass by the weight. The fact that the punty rests on an iron support and is of itself of considerable weight, however, throws doubt on the importance of this factor in judgment. A large number of workers were asked regarding their method of judging the amount of glass necessary to make a bottle of specified weight, and in all cases they declared that their judgment depended upon the size of the gob of glass. Another factor that may be involved is the increase in resistance to turning as the diameter of the gob increases. Finally, it should be pointed out that the amount of glass dripping from the punty can also be judged by the time required for it to drip and by the degree to which it fills the mold. During the preliminary practice period many of the bottles are weighed by the men so that the standard is apparent. In Table 1 the size of punty heads used for bottles of different weights is given; this is seen to vary in proportion to the weight.

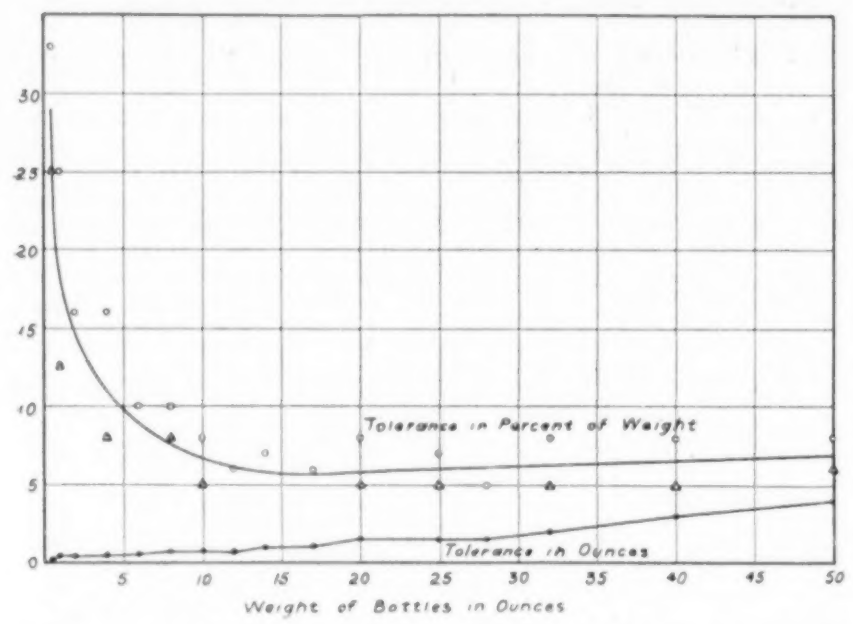

FIG. 1.—Showing allowable deviations from the standard for bottles of different weights. Tolerances above weight are indicated by circles, tolerances below weight by triangles.

Fifty-eight-ounce bottles may be gathered on a punty head with a diameter of 8 cm., while glass for a 1¾-ounce bottle is gathered on a punty head having a diameter of 3 cm. The table also shows the final diameter of a gob of the correct size to contain the desired amount of glass. In the 58-ounce gob it grows to 12.8 cm., while in the 1¾-ounce gob it grows to a size of 4.8 cm. As the judgment, then, is dependent on the size of gobs, the limits to the size are determined by the tolerances allowed. Thus, for the 58-ounce bottle the tolerance would demand that the size of the gob be no more than 13.3 cm. in diameter or no less than 12.3 cm. In like manner the 1¾-ounce gob would have to remain within the dimensions 4.6 to 5.1 cm. On a percentage basis, then, as shown in the table, the tolerances for the 58-ounce bottle are 3.9 per cent. above the correct diameter, and 3.4 per cent. below the correct diameter, while for the 1¾-ounce bottle they are 6.2 per

cent. above and 4.2 per cent. below. Weber's law would determine the deviation which must be allowed in gobs of varying sizes, as it would show the degree to which errors could be avoided; for according to Weber's law a certain percentage increase in the size of the stimulus is necessary before a sensation of appreciable increase in size arises.

attention was called to this size, and the process was then repeated. The diameter of the circle was increased from 5 cm. until the subject called out that it had reached the former maximum size. The circle was then changed to exactly 6 cm. in diameter—*i.e.*, the standard was presented to the subject, decreased to 5 cm., and again increased until the subject called out when the maximum was reached. This was repeated 5 times, so that the subject each time saw the standard 5 and 6, and each time was called upon to judge when 6 had been reached. In a similar way a circle starting at 8 and increasing to 9.6 cm., and one starting at 10 and increasing to 12, were thrown on the screen and 150 observations of each of these circles were obtained. In Table 2 the results, treated statistically, are shown. For the circles increasing from 5 to 6 cm. the mean judgment of the point where 6 cm. was reached was 6.01. The standard deviation and probable error of the mean are low. The coefficient of variability is 7.24. For the circle increasing from 8 to 9.6 the mean is 9.61, and the coefficient of variability 6.63. For the circle increasing from 10 to 12 cm. the mean is 11.96, and the coefficient of variability 5.47. The coefficient of variability is of the same order in all three cases, although it

TABLE 1.—SIZE OF PUNTY HEADS USED FOR BOTTLES OF DIFFERENT WEIGHTS, AND TOLERANCES ALLOWED

Wt. of Gob		Diam. of Punty Head	Diam. of Gob	Tolerance		% Maximum Tolerance of Gob Diam.	% Minimum Tolerance of Gob Diam.	% Wt. Tolerance of Wt. of Gob		Total % in Tolerance	
In Ounces	In Grams			Maximum	Minimum			Above	Below	Diam.	Wt.
58	1644	8.0	12.8	13.3	12.3	3.9	3.4	6.3	5.4	7.3	11.7
14	397	5.5	8.3	8.5	8.0	2.4	3.6	5.1	5.0	6.0	10.1
8	227	4.5	6.7	7.0	6.5	4.5	2.9	6.9	4.6	7.4	11.5
7	198	4.0	6.3	6.6	6.1	4.8	3.2	8.4	5.6	8.0	14.0
1¾	50	3.0	4.8	5.1	4.6	6.2	4.2	15.1	6.4	10.4	21.5

Experimental Support

In order to get experimental support for the conclusion that the weight of gobs is judged by their size, a series of experiments[1] was carried on with students as subjects, in which the measure of visual judgment of size of circles of light was obtained. The apparatus consisted of a calibrated iris diaphragm, through which the light shone on a screen of glazed glass set at a convenient distance. The subject sat on the other side of the screen at a fixed distance and could clearly see the circle of light. A spot of light with a diameter of 5 cm. was thrown on the screen, and the spot was gradually increased at varying speeds to 6 cm. The subject's

[1]Titchener (2) describes experiments for the determination of Fechner's Average Error by use of the Galton bar, a problem similar to the one dealt with in this paper. Harris (3) studied the steadiness of judgment of four individuals who were attempting to pour out a definite number of seeds.

shows a tendency to decrease as the size of the circle increases. The coefficient is sufficiently close, however, to indicate that visual judgment of size is dependent upon Weber's law. The physiology of visual judgment of size is clearly stated in Luciani (1, p. 418).

Comparison of Judgment of Size by Students and by Glass Workers

From inquiries at the glass factory it was found that the workers almost invariably come within the tolerances in making bottles after a period of practice at the particular sized bottle which they are making. The tolerance which is allowed them must, therefore, correspond to a very high percentage of the total spread of the output if plotted on a probability curve according to variation in weight. According to the law of probability, 2½ times the coefficient of variability includes 98.7 per cent. of the cases in a probability curve. In order to have a comparison with the students, we should approximate the tolerances which would be allowed in bottles requiring gobs 6, 9.6, and 12 cm. in diameter. These tolerances would be 8.6 per cent., 6.5 per cent., and 7.1 per cent., respectively, and would correspond to 2½ times the coefficient of variability. Comparing these with figures for the students we have, in the case of students, 18.1 per cent., 16.6 per cent., and 13.7 per cent., the necessary tolerances to be allowed. The greater accuracy of the glass workers may be due to practice effect or to the additional possibilities of judgment which they have in the form of weight and resistance to turning, and in the cutting of the glass as it runs into the mold.

TABLE 2.—RESULTS OF EXPERIMENTS ON STUDENTS TO TEST VISUAL JUDGMENT OF SIZE OF CIRCLES OF LIGHT

Size of Circles (Diam. in Cm.)	5-6	8-9.6	10-12
Mean	6.01	9.61	11.96
Sigma	0.435	0.637	0.653
P.E.M.	0.024	0.035	0.036
C. V.	7.24	6.63	5.47
Frequency	150.00	150.00	150.00
2½ C. V. would have to be allowed in order to get 98.76% correct	18.1	16.6	13.7
Interpolated tolerance allowed glass blowers	8.6	6.4	7.1

Conclusion

We may conclude that judgment of size of gobs of glass required to make bottles of different weights in the glass bottle industry is dependent upon Weber's law. All tolerances which are allowed in the glass bottle industry have been empirically determined and are found to fit in with Weber's law as would be expected. Visual judgment of size of circles also obeys Weber's law. From these facts it may be concluded that in many cases in industry the limits of accuracy to be expected of workers could be determined on the basis of Weber's law, and that in making laws regarding tolerances this fact should be taken into consideration[2].

[2]The American Engineering Standards Committee may establish a series of standard sizes, each size differing by a certain percentage rather than by a fixed increment.

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THE MEDICAL FEATURES OF FACTORY INSPECTION TOGETHER WITH A REVIEW OF THE LITERATURE ON INDUSTRIAL HYGIENE AND INDUSTRIAL DISEASE IN GERMANY IN 1922*

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BEFORE reporting upon new material in the field of industrial disease and industrial hygiene, it is worth while to make a few comments on the development of practical industrial hygiene in Germany.

Germany has at her command a large number of factory inspectors, and German factory inspection has accomplished as much as, and in many directions more than, similar activities in other civilized countries. The results of this method of handling industrial health problems have been surpassed by individual countries only in those directions which necessitate the intensive cooperation of medical men. Until a few years ago, in Baden since 1906 and in Bavaria since 1909, but one physician was employed in factory inspection. A state medical inspector of factories was not appointed in Saxony until October, 1919, and in Prussia none was appointed until the end of the year 1921. Since only five medical inspectors were appointed for the whole of Prussia, on account of limited state funds, the circuit of each is very large. These medical inspectors, who deal exclusively with health problems for the protection of the worker (with the exception of accident prevention), have the right, as have all other industrial inspectors, of surveying trades; and they report at first hand to the minister of public welfare (while the other inspectors are under the ministry of trade).

The nomination of factory medical inspectors and the regulation of their appointments (on April 19, 1922, with additions June 17, 1922) were preceded by discussion in the professional press. Many of the technical factory inspectors (until recently only technicians and chemists were employed in factory supervision) were willing to yield to the doctors merely an unassuming and dependent position. It is in this spirit that Rasch (1), the director of the health inspection of factories in Hamburg, wrote. He was answered by Teleky (2), who referred to the fruitful work of medical men in English factory inspection and to the work of the Bavarian medical inspector of factories, Dr. Koelsch. Beyer (3), head of the department of industrial hygiene in the Prussian Welfare Ministry, emphasized the worth of the personal health-preserving task of medical inspectors. He has handled the whole problem of medical work in industrial hygiene in his book (4), which also contains observations and suggestions in connection with many other fields. He gives a history of factory inspection in Germany and of the co-operation of the doctors in inspection; presents in detail the various unsolved problems of industrial medical work; and discusses the questions of official reporting of industrial diseases, of disease statistics, of the eight-hour day, as well as the importance of applied psychology in industrial hygiene.

In Saxony there has been a more extensive utilization of physicians for fac-

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tory inspection. Not only is there a state industrial doctor, who acts as consultant to the ministry, but in the future, by the order of October 12, 1921, technicians, political economists, and doctors may be appointed for industrial inspection (Schlippe (5)).

For some time, by a series of laws, the authorities have required that in certain health-endangering occupations an admittance examination, supplemented by periodic examinations, shall be given the employee by a physician. Hanauer (6) deals in detail with the position of these examining physicians. He demands their complete independence from the employer (at present they are appointed by the employer and receive their prescribed authorization from the authorities on his proposal) as well as an enlargement of their activity to include all dangerous trades. Teleky (7) demands the appointment of these physicians exclusively by government authorities. With regard to introducing notification of industrial diseases, which is demanded by many, he advocates that only a limited number of industrial diseases be reported, and that these diseases at the same time be considered legally on a par with accidents. Inquiries on every reported case must immediately be made by the medical inspectors and by the examining physicians appointed by the state. He wishes to create a system similar to that of the English.

I may state here that, in the centers concerned, the work has progressed so far that soon a uniform solution of the problem of the supervising physician, as well as the introduction of a limited system of notification, is to be expected. It should be mentioned that a most important measure for the protection of the workman is found in the law of the works council of February 4, 1920. This regulation assures assistance in certain cases involving interruption or change of work, wage questions, and discharge. It is the duty of this works council to see that decisions involving health protection of workmen are carried out.

There is an abundance of material on industrial hygiene in the *Reports of the German Industrial Inspectors* which appear annually in three volumes. To summarize or even to quote the most important matter here is impossible. Since 1909 there has existed an *International Review of Industrial Diseases,* covering the factory inspection reports of the civilized countries, edited by E. Brezina with the help of L. Teleky, and published by Julius Springer, Berlin. This survey takes, every year, from the German, Austrian, Swiss, English, Dutch, French, and Belgian reports (as far as these last two have been published) whatever material is connected with industrial diseases, and usually renders a literal translation of it. The volume covering the years of the war, 1914 to 1918, is especially interesting. The survey based on the reports of 1919 has just appeared; that based on the reports of 1920 and 1921 will come out later in the year.

Of the reports of the German factory inspectors for 1921, only those of the two government medical inspectors need be mentioned. A chemical and bacteriological laboratory has been established by the Bavarian medical inspector of factories, Dr. Koelsch. In one trade dealing with a 70 per cent. lead alloy (this had developed from a very small beginning), there were seventy-three cases of lead poisoning, occurring especially among the grinders and the polishers, and one case of death due to encephalopathy. The necessary protective measures were introduced. Arsenic

poisoning followed the preparation and use of Schweinfurter green—there were four skin cases and two gastro-intestinal cases. Sixty cases of dinitrobenzol poisoning were noticed in workers unloading shells; numerous very slight cases were not reported. The relatively serious initial symptoms (cyanosis and jaundice) quickly disappeared but disturbances of the heart remained longer. No fatalities were reported. The effect of hydrocyanic acid in trades dealing with galvanic baths, and the practical applicability of chemical methods for the detection of hydrocyanic acid were studied. It was found that, when a prompt and clean-cut benzidine-copper sulphate reaction occurred in the air of the workroom, hygienic and technical improvements in the interest of the workers were unconditionally necessary. If no reaction or only a slight reaction occurs within a minute, the surroundings can be considered sufficiently healthful. Investigation of the Allgäu straw hat industry (see p. 217) and of the Neuenberg chalk industry showed that tuberculosis is not so widespread in these industries as has been stated.

From the report of the medical inspector of factories in Saxony (Professor Thiele), it is seen that many cities and districts have complained because the physical weakness and inferior quality of the children who attained school graduation rendered them incapable of working in an industry. Of 217 painters examined, there were 31.9 per cent. with lead line. The lymphocytosis which was observed in many was very striking. Through inquiries and examinations it has been established that Schneeberg mountain illness, pulmonary cancer, is not rare even today among workers in the arsenic and cobalt mines. The investigation of these conditions, which are of such importance in the whole problem of carcinoma, was handled in a broad general manner.

In a longer essay, Thiele (8) describes roughly the industrial situation of the country in which the textile industry is of great importance and industrial home work is very widespread. Both of these industries lead to the employment of a great many women, and the home industries to the employment of children. The state medical inspector of factories has worked for the improvement of first-aid provisions and especially for the introduction of medicine chests containing aseptic materials. The report contains splendid illustrations of dust suction in a card-room, a shoe factory, and a metal polishing establishment.

Before I enter upon a discussion of the scientific publications which deal with special problems of industrial hygiene, it must be emphasized that scientific work is suffering severely from unfavorable economic conditions. The increased cost of printing and of paper, the much lowered economic condition of the group interested in science, and the enforced economy of the authorities result in a situation in which the scientific press has to struggle hard for its existence. Valuable and, in their fields, leading periodicals are about to be discontinued—I mention only the *Archiv für Rassen- und Gesellschaftsbiologie* and the *Archiv für soziale Hygiene und Demografie*, of which only one issue has appeared this year. The *Zentralblatt für Gewerbehygiene* put out its May number in December and announced therein that it was suspending its work but hoped to reappear. If one adds to the cost of publication the cost of simple experimental apparatus—cover glasses, reagents, dyes, etc., the price of which was formerly of little consequence but which today is almost out of reach—

one will understand that the number of scientific contributions is much diminished.

The problem of hours of labor (by the regulation of November 23, 1918, the eight-hour day was introduced into all trades) interests both employers' and employees' organizations most vitally especially since this law, which had its origin in the first days of the Revolution, is now to be replaced by an "hours of work law." Interesting comments are to be found in the *Reichsarbeitsblatt*, 1922, non-official part, p. 63, in which the proceedings of the Committee on Social Politics of the Government Economics Board (*Reichswirkschaftsrat*) are published. A discussion of this work does not belong here because it hardly touches the field of medicine.

Brezina (9), of Vienna, discusses the medical aspects of the length of the working day in an essay on the most practical length of working day and the division of labor, in which he gives an extract from the reports of the British Health of Munition Workers Committee. In another paper on rest periods in industrial occupations (10), he opposes the frequent desire of the working class for the omission or at least for the shortening of rest periods in order to make the closing hour as early as possible (a desire which is shared by the employers in consideration of the economy in general expenses such as heating). He emphasizes the necessity for an additional interval of twenty minutes after lunch in order to give a further rest.

In this field belongs also an essay by Helene Simon (11), in which she refers to the fact that, according to a thorough investigation made by the Verein für Sozialpolitik a few years ago, it is evident that women workers need longer rest hours in order to avoid greater fatigue and loss of efficiency. In developing the new labor laws, especially those affecting women and children, no pains should be spared in combating the existing point of view.

Durig (12) affirms that what leads to the rapid breakdown of the worker is the monotonous, one-sided, and continually repeated use of the same muscles and muscle groups. The fatigue itself is not injurious, but it is the insignificant residual fatigue which in the course of years leads to injury of the muscles. This, it is impossible for us to measure. To overlook this feature of fatigue and to augment its harmfulness through the continuous requisition of the same muscles is the danger of the Taylor system. If we wish to increase production the momentary increased profit from the working capacity of the individual must not be decisive for us; our efforts must not lead to the most intensive and profitable utilization of the worker's capacity for a short period of full work but we must try to secure to the worker the longest possible earning capacity through suitable, foresighted utilization of his forces.

The growing interest in the problems of vocational selection and of vocational guidance is shown less in the number of publications on this subject than in the actual fact that more cities and districts have established vocational guidance bureaus. These are in charge of boards of employment or school physicians. It is hoped that through these agencies each man may be placed in the position for which he is best fitted, that production may be increased, and that the distress of the times may at least be somewhat lessened. In the same direction, many larger industries are choosing their apprentices with the help of a psychotechnical fitness test.

The importance of medical occupa-

tional advice is emphasized by Pryll (13). At the beginning of each pupil's last school year a report in regard to his individual traits should be made by the school physician to the vocational adviser. This adviser must possess a thorough understanding of industry. He must judge of the fitness for the anticipated occupation and give advice accordingly. Such guidance is necessary not only for those leaving school but also for women who, for economic reasons, are forced late in life to enter the business world. The same assistance is especially valuable for war invalids who are entering work. Fürst (14) refers to the utility of psycho-technical examination which, however, under all conditions must be preceded by a physical fitness test. Vocational guidance alone before entrance into a trade is not sufficient, however; health supervision during the whole duration of apprenticeship is also necessary.

The Bureau for Labor Adjustment, Division of Vocational Guidance of the free state of Saxony, has published a guide entitled "Practical Vocational Guidance with Especial Reference to the Physically or Mentally Abnormal or Otherwise Handicapped in Earning Capacity." By way of introduction Kirsch (15) gives an explanation of the management of vocational guidance. The methods of such guidance must not be too set but must be adjusted to both the child and the parent. Teacher, doctor (the school doctor preferably), and psycho-technician must supply the vocational adviser with the fundamental facts upon which, together with his own understanding of industry and of the labor market, he can base the counsel which he gives the parents and the child. The guidance of abnormal, difficult children must always be handled by the general vocational guidance bureaus. Apprentice schools, with medical supervision during apprenticeship, are necessary for many children and should be generally introduced. Such a method of health supervision is being worked out in many places by the continuation school doctors. In the Berlin Guild of Upholsterers, it is being administered on the basis of an agreement between employers and employees. In the following extracts a few specialists write on the vocational guidance of backward pupils, of the deaf, and deaf mutes, and of the crippled.

Important hints for vocational guidance, especially for the health of the young, are given by Kaup (16). On the basis of researches into the occupations chosen by 5,000 Munich continuation school pupils, the author tries to determine what influence occupation has on physical development. From a comparison of the physical measurements of young persons of different ages who have been in industry for varying numbers of years he accepts the following as the effects of trade activity. Among tailors, height is somewhat retarded and there is much restricted growth in breadth; among tradespeople, an abnormal height and much restricted breadth; among machinists, an almost normal height and almost normal breadth; among locksmiths, abnormal height and fairly limited breadth; among butchers, normal height and great breadth. Kaup supplements these statements with the recommendation that both boys and girls in the city and in the country should neutralize the injury growing out of their occupation by physical exercises and he also recommends medical supervision of the young generally. His book, besides its own abundant special material, deals with the total existing literature and draws many interesting conclusions, repetition of which,

however, would carry us too far afield. It is the first book to cover carefully such extensive researches and should be read in the original by everyone interested in these problems.

In the continuation schools (the schools which the young worker must attend), there is a total of only twenty-six school physicians actively employed, according to the statement of Ilse Szagunn (17), who describes her experiences as a school physician in a girls' continuation school in the proceedings of the Berlin Society for the Preservation of Public Health. To the same society Mosbacher reports on his experiences in Charlottenburg. He states that in the Charlottenburg continuation schools 4 per cent. of the skilled, 8.5 per cent. of the tradespeople, and 17 per cent. of the unskilled laborers had to be considered as below normal from the standpoints of nourishment and of working capacity.

In 1921, the deliberation at the Geneva conference upon the prohibition of white lead brought forth a large number of essays and researches which I shall not discuss since they have already found an English answer (18). The German representative to the conference, Lehmann, of Würzburg, in an address on "The Health of Workers in Lead Paint Factories and of Painters in Germany during the Years 1920 to 1921" (19), gave a detailed account of his researches relative to this problem. Out of 400 workers in lead paint factories, 47 per cent. had lead line; 36 per cent., a lessened quantity of hemoglobin; 52 per cent., stippled erythrocytes; 20 per cent., hematoporphyrinuria. The appearance and complexion were poor in 32 per cent., and physical strength below the average in 21 per cent. The number of painters examined was so small that these researches are relatively unimportant.

In regard to the technic for the discovery of the basophile stippled erythrocytes which are characteristic of lead poisoning, Schwarz (20) recommends the examination of a thick blood smear which, according to him, makes a rapid diagnosis possible. Seiffert (21) agrees with him and recommends staining the unfixed blood smear with Löffler's methylene blue. Engel (22) writes in disagreement, stating that, with the use of this dye in an unfixed preparation, many more and, in part, differently formed granules appear in the cells; thus one sees things which are not to be found in the stained fixed preparations. He expresses the opinion that in lead poisoning the number of granules found in stippled cells is extraordinarily increased. Seiffert (23) discusses in detail the conditions found in unfixed preparations. In many red blood corpuscles he found a netlike structure, presenting dark-stained points at the intersection of the meshes of the net. This type of granulation can be distinguished from true stippling because of the darker staining and sharper contour of the granules in the latter condition. Also the true granules are intensified in the fixed preparations, since in unfixed material the smallest granules are visible on account of swelling. One must also be careful not to mistake the false granules mentioned above. True stippled erythrocytes found in five or six fields indicate lead action on blood cells. Schreiber (24) obtained a similar result by examination of fresh preparations which were stained with a very complex "combined brilliant cresyl blue Giemsa dye."

A publication of Stiefler (25) may be mentioned here, although it does not

deal with industrial diseases. Many cases of lead poisoning occur among the peasant population of Upper Austria through keeping home-made fruit wine in badly glazed receptacles and especially through the use of lead pipes in connection with wine presses. One physician saw 100 cases of poisoning in twenty-five years' practice. Cases of lead paralysis frequently occur, and cases of fatal encephalopathy are also reported. Often a wrong diagnosis is made and cases of lead colic are thought to be appendicitis.

A bibliography of lead literature edited by Else Blänsdorf (26), librarian of the Institute for Industrial Hygiene in Frankfurt am Main, has been published. The bibliography includes 3,000 titles in every language but, as is stated in the introduction, there are still gaps in the work in spite of its size. It is the first compilation of the widely distributed and comprehensive literature on lead poisoning.

Reis (27) reports on diseases of the optic nerve brought on by trinitrotoluol. Visual disturbances appeared in one instance after fifty months' work, and in another case after four and one-half months' work filling shells; while a central scotoma developed gradually in the first case, optic neuritis led to blindness within twenty-four hours in the second.

Hunziker and Koechlin (28) report on a case of poisoning with para-nitrochlorbenzol. A child 3 years old found a bowl of this yellow crystalline substance near a factory and put some in his mouth; severe cyanosis, an irregular, extraordinarily rapid pulse, motor unrest, excitement, then vomiting followed by transient severe albuminuria developed. All phenomena disappeared in the course of two to three weeks.

Several works deal with the diseases of glass workers. Reichert (29) writes on the occupational injuries to the mouth and teeth of glass workers. He reports typical ulceration on the lips, thickening of the mucous membrane, lacerations on the cheek, the widening of Stenson's duct, and the characteristics brought about by blowing, the wearing of the incisor teeth and their abnormal position.

Wick (30) has published researches on glass blowers' cataract. He examined 158 glass blowers in a glass bottle factory; of the men from 40 to 60 years old 32.4 per cent., and of the men over 60, 73.3 per cent. had cataracts. He accounts for this number being larger than that of other investigators by the fact that he examined pupils enlarged by the use of atropine. He found posterior cortical cataracts in only 25 per cent. of the cases, whereas Legge found them in 50 per cent. of his. It is worthy of notice that before the windows of the furnace blue and gray protective glasses were in general use in the factory, which were proved, by an optical examination, to allow the passage of every kind of ray.

Teleky (31) reports on a typical disease of glass cutters. He was able to determine atrophy of the small muscles of the hand in eight glass cutters, especially in the first interosseous muscles of the left hand. This well-known disease of glass cutters has its origin in the pressure on the *nervus ulnaris* in the *sulcus ulnaris humeri* brought about by constant leaning on the elbows. With change of work and a straightened position a slow and more or less complete recovery took place. Lippold (32), the owner of a glass factory, describes a blowpipe which works with compressed air and which after preliminary opposition is now much liked by the glassmakers.

Kazda (33) reports on the traumatic

origin of *ulcus ventriculi.* A ropemaker who hit his left ribs many times a day with the "knife" while making belts by hand (this work is now done entirely by machine) developed a large callus followed by pyloric stenosis and ulcer. In the case of an engraver who leaned the heavy copper plates against his abdomen, an ulcer developed on the front of the abdomen.

Chajes (34) describes eruptions appearing in seven out of thirteen persons working with a glue containing 0.5 per cent. formalin.

Koelsch and Seiffert (35) report on the distribution of tuberculosis in the Allgäu straw hat industry. This industry has been carried on as a home industry for decades, and the sedentary life in closed rooms and the long hours are certainly unfavorable to the workers. These harmful conditions, however, are offset by the good incomes earned and particularly by the fact that the production of straw hats is carried on only in winter, while from May to October agricultural work is done. This change of occupation, together with the higher wages earned in home work, has such a favorable influence that the death rate from tuberculosis among the workers in the straw hat industry is lower than that of the rest of the population.

Chajes (36) gave an address on accident hazards and diseases of employees of the gas, electric, and water works as well as of firemen, before the respective meetings of these groups of workmen. As to accidents, the safety of retort and oven workers depends largely on technical arrangements which are very different in the old and in the new works. In the new works the loading and unloading of the retorts is mechanical and the number of workers is small. Among the cases of illness arising from occupational injuries, accidents and respiratory and rheumatic diseases figure largely. Only thirty-nine cases of poisoning from illuminating gas were confirmed in nineteen years in all the German gas factories. For the morbidity rate of official fire brigades, Chajes (37) has collected the sickness statistics of the Berlin fire department from 1912 to 1919, of the Munich department from 1879 to 1894 and from 1912 to 1920, of the Breslau department, and for 1920 to 1921 the statistics of the city fire departments and of the factory fire departments. There is considerable variation in these figures. The morbidity statistics of Berlin and Munich show a striking difference in the years before and after the war, much to the advantage of the latter years. The author thinks that this is due to the shortening of the working hours and to the introduction of rest shifts.

In closing it will be well to consider an endeavor from which new material for the study of the influence of occupation on health is expected. Attempts are being made to use for this purpose the abundant material lying in the Sickness Insurance Companies. Insurance Companies in Austria are required to submit a yearly report in the form of detailed morbidity statistics (including over 100 diagnoses) to the Ministry. The attempt to reach true illness statistics has failed because the data were too unreliable. The question of illness statistics has been considered by the German insurance companies for a long time. A few of the larger companies send with their yearly reports statistical data on diseases but since each of the companies makes out and edits its statistics in a different way no comparison can be made. Furthermore the material is usually not classified by occupations. Recently the Federations of Insurance Companies of the Rhine

Province, under the presidency of the state medical inspector of factories, adopted at a general meeting a common plan for reporting disease and occupation, and also a common outline for the statistical report of disease notification. These act according to the special requirements and characteristics of insurance company accounts, and thus, on one hand, give an idea of their most important problems, and on the other make possible the collection of statistics without much extra expense. Since the Federation of Insurance Companies of Westphalia has joined this movement and since large companies outside of this region are proposing to publish their statistics according to the same outline in the future, it is hoped that abundant and comparable material will be obtained. The insurance companies and unions are to use this material for their own purposes, and it is also to be given to the factory medical inspectors so that they may use it as a guide for their work and may obtain from it information in regard to diseases arising from various professions or trades.

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THE DUSTED LUNG WITH SPECIAL REFERENCE TO THE INHALATION OF SILICA DUST (SiO_2) AND ITS RELATION TO PULMONARY TUBERCULOSIS*

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INTRODUCTION

IT is now generally agreed that dust found in lung tissue gains access by way of inhalation. Certainly in the case of animals, experimental work has demonstrated that dust can and does reach the alveoli of the lungs by this channel. Other paths of entry, such as by the digestive tract, may for all practical purposes be neglected. The respiratory apparatus possesses definite means for ridding itself of dust—*i.e.*, (1) the power of the bronchial secretions to dissolve dust particles; (2) the sweeping out action of the cilia lining the bronchi and the bronchioles; and (3) the phagocytic action of macrophages which remove particles from the alveoli and carry them either within reach of the cilia, or through the alveolar walls into the lymph stream. These means may, however, be overwhelmed if the amount of dust inhaled is excessive, or if the period of inhalation is prolonged, when, according to Mavrogordato (1) "any dust inhaled in sufficient quantity will get well ahead of any possible elimination of the lungs;" the same author also considers that "all dusts that invade the lung provoke the production of cells that may turn into white fibres and increase the amount of fibrous tissue."

Inhalation of such excessive amounts of dust does not occur in practice. The interesting point is that clinical experience and mortality statistics for human beings, and experimental work on animals, show that the results which follow the inhalation of dust vary with the kinds of dust inhaled.

Size of Particles.—Dust particles inhaled into the air passages may be divided into two classes: (*a*) those which are too large to pass through the finer bronchioles (*e.g.*, those over 10 microns in diameter); and (*b*) those which are so small that they can penetrate into the alveoli directly. The latter particles more immediately concern us, for according to McCrae (2) no particles have been found in the lung tissue which exceed 10 microns in diameter, and over 70 per cent. of those found are 1 micron or less. In order to pass into the alveoli, dust particles must, therefore, be very small; otherwise they are caught in the mucous secretions and are expelled by the ciliated epithelium.

Solubility.—If dust particles are to act as foreign bodies and give rise to irritation by accumulation, they must be insoluble in the bronchial secretions. Soluble dusts, such as organic dust and lime, may, therefore, be dismissed from notice for the present, as their inhalation is followed by little or no organic change. Attention must be focused upon those inorganic particles which are injurious either on account of their chemical properties, or on account of their insoluble nature.

Path of Ingress.—Dust particles which have reached the alveoli are in-

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gested by macrophage cells, called by Mavrogordato (1) "dust cells," which originate from epithelium lining either the alveoli or the lymph channels. These dust cells are identical with the macrophages of Metschnikoff, and the ingestion of dust particles by them is an illustration of phagocytosis. Aseptic particles are dealt with by the tissue phagocyte or macrophage, while micro-organisms are dealt with by the blood, phagocyte, or microphage. The phagocytes deal with the dust particles, then, in much the same way as they do with micro-organisms. The process consists in the phagocytosis within the lung alveolus by a cell which is probably an endothelial leukocyte. This view of endothelial origin of the dust cell is now generally accepted; and apparently only dust which reaches the alveoli is dealt with by phagocytosis. Haythorn (3) examined strips of terminate mucosa and never found pigment-bearing cells beneath epithelial lining, and concluded that the amount of pigment phagocytized in the air passages above the alveoli must, therefore, be a negligible quantity. These macrophage cells are not transient scavengers, but in leisurely manner they gather their pigment load and convey it to the periphery of the lung.

Subsequent Proceedings.—This path of entry explains why dust is to be found in the glands draining the pleura of experimental animals before it can be found in the glands serving the bronchial lymphatics. According to Mavrogordato (1) all dusts, after they have entered the pulmonary tissues, exhibit this "early pleural drift," and in the case of silica dust, at least, the dust-laden cells flock together to form pseudo-tubercles in, and immediately beneath, the visceral pleura.

Corroboration comes from experiments by Willis (4) with coal dust; he found that the dust tended to gather at irregular intervals in the interlobular subpleural spaces, while in animals previously injected with tubercle bacillus the dust particles were somewhat more abundant in the pleural and subpleural foci than elsewhere.

Inorganic particles have the capacity of producing inflammation; for, as Adami (5) points out, inflammatory conditions are not always the result of bacterial activity, "and to say, as some surgeon-pathologists insist, that because bacteria cause the acute inflammation most commonly encountered, and that which most frequently demands treatment, therefore, inflammation is always the result of bacterial activity, and anything not caused by bacteria is not inflammation, convicts one, to put it in moderate language, of a certain lack of breadth of vision." Mavrogordato (1) and Hugo Romanis produced experimentally excessive fibrosis in the peritoneal sac of the rabbit by dusting the serous membrane with sterilized silica and coal.

Certain tissue changes, the result of inflammation, take place in the following order (1): (1) the formation of pleural pseudo-tubercles, or nodules; (2) the formation of free pseudo-tubercles; and (3) the blockage of lymphatics.

The pseudo-tubercles, or nodules, are composed of dense fibrous tissue which shows a concentric arrangement of dust fibers, the denser tissue being nearer the center. Outside this there is a stratum of less dense and younger fibrous tissue, and surrounding this is an area of cell proliferation. The center itself often shows changes which suggest a necrosis of the tissue, the tissue here being looser in texture and less definite in structure, and it is important to observe that it is in this situ-

ation (the necrotic center) that the tubercle bacillus is found in silicotic lungs, when typical tuberculous processes may not be evident elsewhere in the lung tissues (6).

With the increase of fibrous tissue a gradual obstruction of the lymphatics occurs, with a consequent further accumulation of dust cells; a more and more diffuse fibrosis now appears, which follows the distribution of the lymphatics, accompanying the ramification of the bronchial and vascular trees from their origin within the lobular region to the termination of the lymphatic system in the bronchial glands. The distribution of the mineral particles suggests that the perivascular lymphatics are affected earlier and more severely than are the peribronchial lymphatics. This fact gives strength to the hypothesis that the blood vessels become obliterated before the corresponding bronchiole is rendered incapable of functioning, and that indeed the formation of fibrous nodules in the perivascular tissue may determine the fibrous obliteration of the bronchiole as a secondary stage of the process. This conversion of blood vessels into fibrous rods does not cut off the blood supply permanently because these fibrosed tissues are re-vascularized (1). Shattock (7), in his description of "dust knots" (fibrotic nodules), insists upon the fact that each is associated with a nutrient artery. This re-vascularization accounts for the tissue hypertrophy which is seen in these cases; for the "dusted lung" (due to silica dust) is characterized by increase in bulk and weight, and instead of being soft and spongy it becomes firm and unyielding. Pleural adhesions are nearly always present, and the pleura itself is thickened. On section, the cut surface presents an appearance of scattered nodules of a grayish-black color, from 2 to 5 mm. in diameter, more or less rounded in form and distributed throughout the lung tissue, the intervening parts being usually emphysematous. Cavities may be present up to 2 inches in long diameter, as in the cases reported by Dr. Greenhow and Dr. Andrewes (cited by Middleton (6)). If the lung is dried and incinerated, the ash is found to contain silica. In one analysis reported by Scholberg (cited in (6)), the ash contained 36 per cent. of silica.

The Harmfulness of Dusts

Clinical records regarding the incidence of dust fibrosis, as a separate entity, are today lacking; but they should become available when the provisions of the Workmen's Compensation (Silicosis) Act are extended outside the refractories industry, which by itself employs hardly enough persons to afford reliable data.

Statistical evidence of the harm done by inhaled dusts is based almost exclusively upon mortality records. Owing to the possibility of errors arising from attributing to tuberculosis deaths from pure fibrosis, or deaths which originated from fibrosis, all deaths ascribed to such diseases as phthisis, pulmonary tuberculosis, fibroid phthisis, and miners' phthisis, are grouped together and compared for different classes. Any excess found in a class exposed to dust inhalation as compared with the general population is then ascribed to the influence of dust. If we accept the view that such excess is some indication of the existence of dust fibrosis, statistics are found to support the idea that fibrosis bears a relation to the amount of free silica (SiO_2) in the dust.

Derbyshire may be taken as an example; the eastern half is largely a coal

field; the northwestern district consists of limestone and sandstone strata, chiefly lower limestone; the central district consists chiefly of sandstones (*e.g.*, gritstone, ganister, toad, and burrstone). Barwise (8) has shown that while the phthisis death rate for the general population was 1.49 per 1,000, in the gritstone area it was 7.0 per 1,000 persons employed; in the limestone area it was 1.71; and in the coal area, 0.68. Derbyshire gritstone contains 96.4 per cent. silica, limestone contains only 0.2 per cent., and pure coal none.

Coal Dust

The low phthisis rate among coal miners is striking and is peculiar to coal mining all the world over. Wainwright and Nichols report this from America, De Crocq from Belgium, and Arnold from Germany. Coal would appear, then, to exert some protective action against tuberculosis; but the evidence is not certain since statistics show that, low though the phthisis mortality is among all coal miners, men at the coal face, who are particularly exposed to dust, experience a higher mortality from phthisis than do other miners. Experimental evidence is also conflicting; thus Wainwright and Nichols (9) found, on infecting guinea-pigs (previously rendered anthracotic with coal dust) with a pure culture of tubercle bacilli, that although the abdominal glands showed signs of tuberculosis, the lungs remained free; but other workers have not confirmed these results.

Experiments carried out by Mavrogordato (1) throw some light on the subject; one group of guinea-pigs was exposed to silica alone, a second to silica followed by coal, and a third to silica preceded by coal. The animals were killed after six months, and the lungs of the animals of the first group were found to be gray, those of the second black, and those of the third white. These experiments are regarded as indicating that once silica is fixed in the lung tissue, coal exerts no eliminating action, but that a prior, or even a simultaneous, exposure to coal dust sets up a condition in the lungs which is inimical to the fixation of silica. Mavrogordato (10) considers that coal and shale dusts stimulate the forces of elimination; these dusts enter the lungs with great readiness, but are taken up by cells which are quickly shed and consequently do not set up processes which block the lymphatics. He maintains that coal dust produces a catarrhal reaction, and that this reaction is helpful in eliminating inert silica dust along with coal dust.

Lime Dust

Lime workers also experience a low death rate from phthisis. Inhalation of lime dust is not followed by extensive fibrosis; the dust is soluble in the body fluids, and the resultant changes are mild. Radiography discloses a general haziness throughout the lung without the formation of particulate or reticulate shadows. This appearance I have seen again and again on examining chests of lime workers by X-ray; it is due, in my opinion, to a mild diffuse fibrosis of the lung tissue, possibly caused by the small amount of silica present in lime; but limestone quarries are intersected by bands of sandstone, and limestone workers may thus be exposed to a varying amount of sandstone dust, just as may coal miners.

Marble dust, which contains 49.5 per cent. calcium oxide, is largely dissolved in the body fluids; but a remainder, ac-

cording to Gardner (11) is deposited in cases infected with tuberculosis in the pulmonary tracheo-bronchial node tubercles, this deposition only taking place, however, in previously injured tissue and never in normal tissue. Selkirk has called attention to the rarity of tuberculosis among lime workers in Edinburgh, while Fissak puts the death rate among turners of gypsum (calcium sulphate) in Germany as low as 0.41 per cent. (see Gardner (11)).

The experimental work of Cesa-Bianchi (12), corroborated later by Gardner (11) and others, has shown that the inhalation of lime or marble dust does not prevent the rapid spread of tuberculosis in the lungs of guinea-pigs. Hoffman (13) gives the death rate from tuberculosis among lime workers in Vermont, 1913 to 1919, as 3.8 per 1,000; but American limestone has a silica content of 1.2 per cent. as against 0.2 per cent. in Derbyshire limestone. Evidently limestone belongs to a class of dusts which neither accumulate, nor excite the powers of elimination—facts which account to a large extent for the absence of severe and lasting pathological changes.

Silica Dust

Other mineral dusts present different results. Workers in the central district of Derbyshire show a high mortality from phthisis. They are chiefly occupied in quarrying, mining, or cutting gritstone, burrstone, and ganister, which all have a high content of pure silica (85 to 96.4 per cent.). Some are occupied at the refractories industry—*e.g.*, silica brick makers and ganister crushers; a few work in the local lead mines (which have strata of quartzite and calcite to be cut through); and in the south of the County we have a number of workers engaged in the pottery and sanitary-earthenware trades, wherein a mixture of ball clay, china clay, flint, and Cornish stone is used which has a silica content of from 10 per cent. to 25 per cent. All these workers may show signs of more or less fibrosis in their lung tissues, although the period of time elapsing varies in the different occupations. The period, of course, varies also with the intensity of exposure, but this being equal it is always found to be shortest where the silica content of the dust is greatest; thus, in the case of gritstone and quartzite workers the period of exposure is as short as from 5 to 10 years; —in ganister and granite workers it is about 10 to 20 years; and in pottery workers a period of over 20 years' exposure is the general rule. Middleton (6) puts the period in some of his cases as low as 2 years in workers in silica dust, and Oliver (14) puts the period in the rock drill workers of the Witwatersrand (South Africa) as from 6.8 to 8.8 years. Most authorities agree upon an average period of exposure of from 10 to 15 years as being necessary for the production of symptoms—the American workers put it at 15 years.

Symptomatology

Positive Signs.—At first there is little to note beyond irritation of the mucous membranes of the nose and throat, the sneezing and coughing which ensue being nature's attempt to dislodge the dust. The cough is usually the first symptom; it is short and paroxysmal, occurring mostly at night and in the morning. Later it is accompanied by expectoration which, at first scanty, is increased in quantity as the mucous membranes of the bronchi become involved.

The second, and often the dominating symptom, is dyspnea (sometimes this is

the first and almost the only symptom). As the fibrosis becomes more extensive and reduces further and further the functioning area of lung tissue, this symptom becomes very marked, the patient complaining "that he cannot get to the bottom of his breath."

Sooner or later a third and important symptom may assert itself,—namely, hemorrhage. This occurs in about one-third of all recorded cases. Middleton (6) records it as occurring in sixteen of the fifty-seven cases investigated by him, and says that it varied in amount from definite coloration of the sputum to quantities of a pint or more. In two of his cases and in one of my own the hemoptysis was so severe as to prove fatal. In both of his fatal cases, and in my own case also, tubercle bacilli were found in the sputum. Hemoptysis may be present, however, in cases which show a sputum which is negative for tuberculosis (about one in three of my negative cases showed this symptom), and is probably the result of ruptured vessels in the walls of bronchiectatic cavities. There is usually a good deal of bronchitis, and where the fibroid changes have become marked there is quite likely to be manifested a bronchiectasis.

A fourth symptom, and usually a very early one, is pain in the side. It is probably due to an early pleuritis, and is explained by the early pleural drift of dust cells which takes place in these cases. It is interesting to note that a similar early symptom often manifests itself in tuberculous disease of the lung; early pleurisy is, in fact, one of the most familiar conditions in pulmonary tuberculosis and may be present months before any signs can be demonstrated clinically in other parts of the lung. It is probably due to the same cause—*i.e.*, the transportation of macrophaged, or phagocytized, bacilli to the subpleural spaces.

Negative Signs.—There is as a rule an absence of fever; night sweats are uncommon; there is little or no loss of flesh; and malaise is not met with to any marked degree. The distinguishing feature of general fibrosis of the lungs is the contrast between the extensive pulmonary lesions and the absence of marked constitutional symptoms. On inspection, the patients as a rule are pale in appearance but seldom show a typical toxemic cachexia as in tuberculosis. The chest is usually flattened anteriorly, and there is some roundness of the shoulders. The barrel-shaped chest is not usually met with; the expansion of the chest is always diminished and usually, but not always, equally so on both sides; occasionally it is unilateral. In the beginning the percussion note may be normal, but resonance is usually reduced, especially over the upper lobes; the dull areas may be bilateral or unilateral; if emphysema exists, in parts the note may be hyperresonant. On auscultation, the breath sounds are invariably deficient in intensity, especially at the bases, and have a peculiar "whiffing" quality which may be almost described as characteristic (this symptom was well marked in a case of my own). Adventitious sounds are usually of the nature of fine sibilant rhonchi, and these may be heard in any area. True amphoric breathing is, however, seldom heard except over bronchiectatic cavities or in cases complicated by tuberculosis. Although in fairly early cases the signs show some contrast to those of pulmonary tuberculosis, the physical examination does not as a rule lead us far, for as the disease advances the signs become more and more like those of tuberculosis, and the differential diag-

nosis becomes increasingly difficult. Two things ought never to be omitted in these examinations—namely, (1) the radiographic examination of the chest, and (2) the sputum examination for the presence or absence of tubercle bacillus. For this the best method to adopt is the antiformin, which gives more accurate results than the older method of Zeil Neilson. These sputum examinations should be done at regular intervals over a prolonged period, and the results should be carefully recorded.

A distinction is here drawn between infective silicosis, a condition in which the tuberculous lesion is open and can infect others, and infected silicosis, a condition in which infection may have occurred when the dust particles were inhaled but has become walled off and protected from destruction by layers of fibrous tissue—*i.e.*, a condition of closed and latent tuberculosis. No method of clinical diagnosis can at present distinguish between a case of infected fibrosis and one of simple fibrosis. The presence of an original infection, however, is all important to the future; sooner or later the infected fibrotic nodule breaks down, and then bacilli are poured upon tissues deprived of normal defensive forces. The case becomes an open one and progresses rapidly to a fatal termination. If the dust was not infected, then withdrawal of the patient from further dust risk should suspend any advance in the pathological condition.

Cases Illustrating Non-Infective or Simple Silicosis

Case 1.—T. B., aged 54, worked as a potter for twenty-five years in the sanitary-earthenware trade. He was admitted to my dispensary on June 10, 1917; his weight at that time was 8 stones. The clinical signs on admission were those of a bilateral basal fibrosis, with a marked paravertebral dulness and a few bronchitic sounds throughout. Sputum was scanty and blood-stained. Dyspnea on exertion was the patient's chief complaint; no elevation of temperature and no night sweats occurred. The sputum on examination proved to be negative for tuberculosis. The patient was sent to the sanatorium for further elucidation of diagnosis and was discharged in August, 1917, the diagnosis given being: fibrosis only, "silicosis." I did not see him again until March 31, 1919; presumably he had gone back to work till then. His clinical signs now included a small cavity in the left upper lobe. The sputum was blood-stained, but it was negative for tuberculosis by antiformin examination. There was an increase in the amount of dyspnea present. He gave up his pottery work at my request and opened a small shop. On examination on March 14, 1921, he was found to be *in statu quo*; his weight was maintained, being 8 stones 1 pound 8 ounces; his temperature was normal; his sputum was still negative for tuberculosis, but the dyspnea remained a marked feature, and there was an increasing emphysema. He grew steadily worse with increasing emphysema and bronchiectasis, and died in the autumn of 1922, his death being registered as from "acute pulmonary tuberculosis." Unfortunately I had not an opportunity of examining his sputum during the last year that he was alive, but until then, at least, he showed no signs of a tuberculous infection and his sputum over a period of five years' observation remained negative for tuberculosis.

Case 2.—H. B., aged 50, had been a sanitary-earthenware potter for thirty-five years. He was admitted to my care on May 26, 1919, with clinical signs of a bilateral fibrosis, most marked on the right side, with some bronchitis and compensatory emphysema. There were no hemorrhages, no night sweats, and no loss of weight. The sputum remained negative for tuberculosis throughout a period of three years' observation, during which time the man gave up his trade; the emphysema increased, however, and he died in 1922. His death was certified as from "emphysema and asthma." The case was one of non-infective silicosis.

Case 3.—T. L., aged 52, had worked for thirty years as a sanitary-earthenware potter. He was admitted to my care on April 3, 1919, weighing 11 stones 2 pounds. The signs observed were bilateral fibrosis with considerable dyspnea; some fine wheezy râles scattered throughout the lungs; sputum scanty and negative for tuberculosis on examination. There was an absence of fever, night sweats, and malaise. The man was ro-

bust in appearance, and had a slightly bronzed complexion. He was asked to give up his trade, and he obtained other employment. He has gained steadily in health during a period of four years' observation, and has increased in weight; the asthmatic symptoms have now nearly abated, although there is still some dyspnea on violent exertion. He is working daily now. This was a case of non-infective silicosis with a sputum constantly negative for tuberculosis, illustrating the fact emphasized by Mavrogordato that non-infective silicosis will not advance if the sufferer is removed from dusty trades, and is put to work under more healthful conditions.

Case 4.—J. T., aged 44, employed as a cast-iron pipe cutter for twenty-seven years at the S— Ironworks, Derbyshire, was admitted to my dispensary at Ilkeston on January 8, 1923, complaining of cough and extreme dyspnea. Clinical examination showed that there had been a recent pleuritis of the left base. There was dulness to percussion over both apices, with deficient breath sounds; air intake was poor all over the chest. Both Kronig's areas were contracted; the right Kronig's area measured 1¾ inches, and the left 1½ inches. The breath sounds, especially in the bases of the lungs, showed markedly the whiffing quality already referred to as characteristic of fibrosis. There were no night sweats, no loss of weight, and no fever. Dyspnea was the paramount symptom. The sputum was thin and watery and was found on examination to be negative for tuberculosis. An X-ray showed the case to be one of medium fibrosis. This case is still under observation.

Case 5.—A. L., aged 40, had worked twenty-two years as a potter's polisher. His weight on admission to the dispensary under my care was 7 stones 8 pounds. Clinical signs observed were: chest shrunken, fibrosis over both bases, and some thickening of the pleura at the right base; relative dulness at the left apex posteriorly; marked dyspnea; temperature 98.4° to 100° F. (evening). The sputum was negative for tuberculosis. Fluorescent screen showed mottled shadows in both hilus regions and branching to the apices. The right diaphragmatic action was impaired, and there was a dense shadow at the right base (like a pleural effusion). The patient was sent to the sanatorium on February 15, 1922, and was discharged on April 29, 1922. He was kept absolutely quiet in bed during that time and his temperature fell to nearly normal. The sputum was consistently negative on examination and the Medical Superintendent's report was "dust fibrosis, with bad general condition, cyanosis, high temperatures, tachycardia, and toxemia. There is possibly (as the toxemia and temperature would seem to indicate) a superadded tuberculous infection, but the signs are mainly those of a dust fibrosis." This illustrates a case in which the diagnosis was doubtful.

Radiographic Examination

In all early cases of dust fibrosis the radiographic examination may be of the greatest assistance in the diagnosis. The radiographic appearances of these cases can usually be divided into three stages.

First Stage. — Mavrogordato (1) claims that there is a pre-X-ray stage of silicosis because, although the earliest stages of silicotic processes, associated with the formation of pseudo-tubercles, may readily be detected by the microscope, X-ray examination fails to reveal any evidence of silicosis until the fibrosis of the lymphatic vessels has begun. After this pre-X-ray stage the hilus shadows are always increased. There is also an undue prominence of trunk shadows and the finer linear markings. The descending trunk shadows are more noticeable on the right side, the heart shadow obscuring those on the left.

Second Stage.—This is characterized by a more or less uniformly arranged mottling diffusely scattered throughout the lung structure, due to the deposit of dust in the lymph spaces, cells, and fibrous tissue spaces, together with some localized fibrosis. This mottling is of a particulate character, denser in the center and with soft edges, which gives an appearance, in well marked cases, of a characteristic nature. It has been called by the South African workers the "snow-storm" appearance (Fig. 1).

Third Stage.—The fibrosis in this

stage has become more general, lighted up here and there by emphysematous patches, with the mottling showing a tendency to become denser and to coalesce, losing its more particulate character and forming denser and more uniform shadows. The condition in this stage is indistinguishable from advanced tuberculosis. The condition is always bilateral, although perhaps often more marked in one lung (usually the right) than in the other; it commences at the hilus and spreads at first toward the base; these features are somewhat in contrast to the behavior and spread of a tuberculous fibrosis which is more often than not unilateral, and which, commencing at the hilus, spreads first toward the apices. The shadows in tuberculous fibrosis are also less particulate in character (except in old standing or advanced cases), and tend more to assume a reticulate formation.

Case 6.—J. W., aged 51, for twenty-seven years a sanitary-earthenware potter, was admitted to my care on August 23, 1918, weighing 10 stones 5 pounds, and displaying clinical signs of fibrosis in both upper lobes. He complained of considerable dyspnea and some asthmatic trouble, but had no fever or night sweats. This patient presented on inspection (even then) a characteristic appearance of a silicotic chest, stooping shoulders, flattened (almost retracted) apices, enlarged veins over the upper part of the sternum, some muscular wasting (but no marked emaciation), and a rather pale complexion. He was slightly cyanotic in colder weather. The breath sounds exhibited that peculiar whiffing quality mentioned above. His sputum was negative for tuberculosis on admission. He was sent to the sanatorium on September 4, 1918, and throughout his stay there his sputum was negative, and his temperature subnormal; he gained in weight. The Medical Superintendent's report was: fibrosis only, "silicosis." During 1918 he had repeated small hemorrhages; he worked on at his trade until June 17, 1920, when he again complained of great dyspnea and on examination showed signs of bronchopleurisy at the base of the spine of the left scapula. His sputum was again negative for tuberculosis on January 10, 1921; his weight was 10 stones 9 pounds—4 pounds greater than on admission—and he continued at work. He was not seen again until August 10, 1922, when it was found that, during the eighteen months which had elapsed, he had lost 18 pounds in weight. He was very ill, and his sputum on antiformin examination now proved to be positive for tuberculosis for the first time; he was re-admitted to the sanatorium on August 16, 1922, and discharged on November 4, 1922, his weight having risen to 10 stones 10 pounds (a little greater than his original weight on admission in 1918). His sputum was negative for tuberculosis while in the sanatorium; he changed his occupation to a non-dusty one and, when last examined on February 15, 1923, his sputum was again negative; his weight was 10 stones 8 pounds; there was very little cough or spit; and his only complaint was of dyspnea which still occurred on exertion. This man continues in fair health and at work daily. The case illustrates the need for careful observation and sputum examinations, as in a period of six years of observation this man has only once shown a sputum positive for tuberculosis and that at the only time when his weight underwent a serious fall (18 pounds in eighteen months). This was a case illustrative of the closed tuberculosis and silicosis type of which Mavrogordato speaks, the number of years that the infection had remained closed being a matter of conjecture. (See Fig. 2.)

Case 7.—W. W., aged 53, a gritstone mason for forty years, was admitted to our sanatorium on August 27, 1919. His weight on admission was 8 stones 4 pounds; his sputum was negative for tuberculosis and remained so throughout his stay of three months. The clinical signs were: symptoms of fibrosis and emphysema all over both lungs; dulness to percussion, and retraction under both clavicles. Tactile vocal fremitus and vocal resonance were both positive; air entry was poor all over. The breath sounds were harsh and of a whiffing character. At the sanatorium his weight was increased and his dyspnea improved; he was discharged on November 18, 1919, to use an open-air shelter in his garden. He gave up his trade and has maintained his health. The radiogram is a good example of medium fibrosis (Fig. 3).

The macroscopic and microscopic appearances have already been referred to earlier in the paper, and are also considered later in a postmortem report of one of my own cases. Although several of the mineral dusts produce more or less fibrosis, yet only dusts which contain a large percentage of silica are followed by an intense fibrosis.

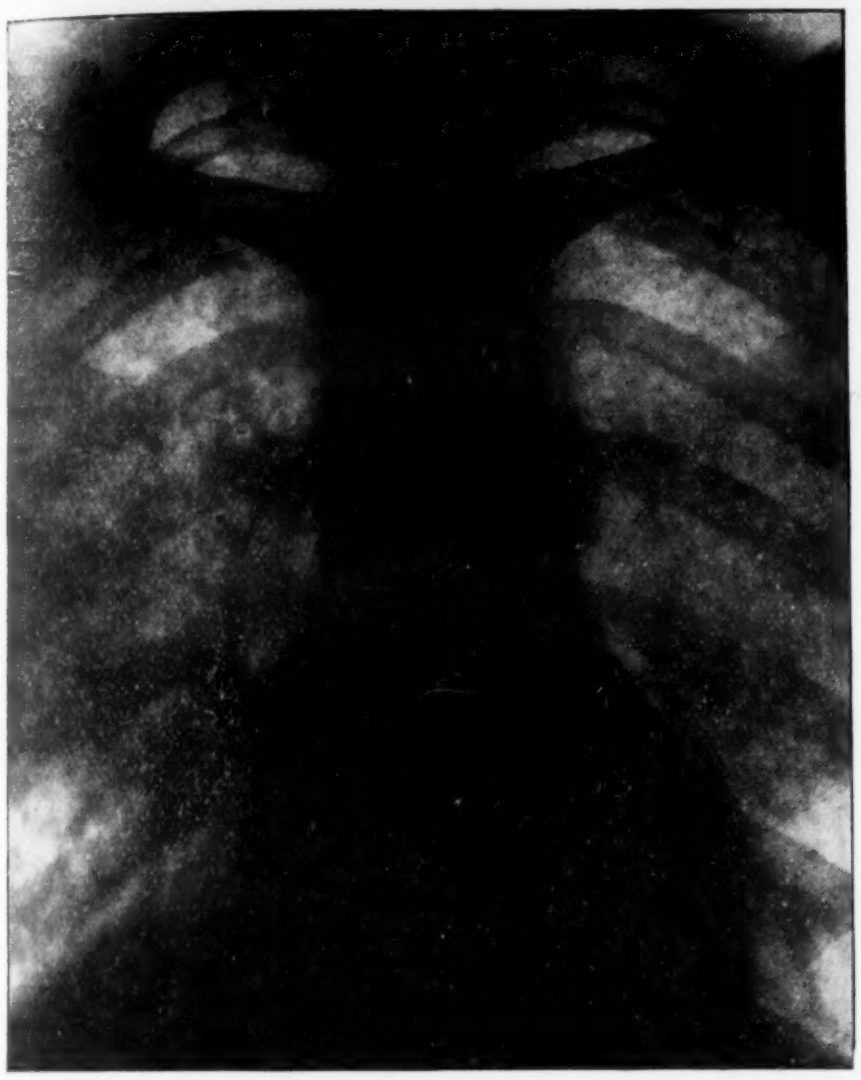

FIG. 1.—Snow-storm effect. Non-infective. A. M., ganister miner for fifteen years, whose only symptom was dyspnea.

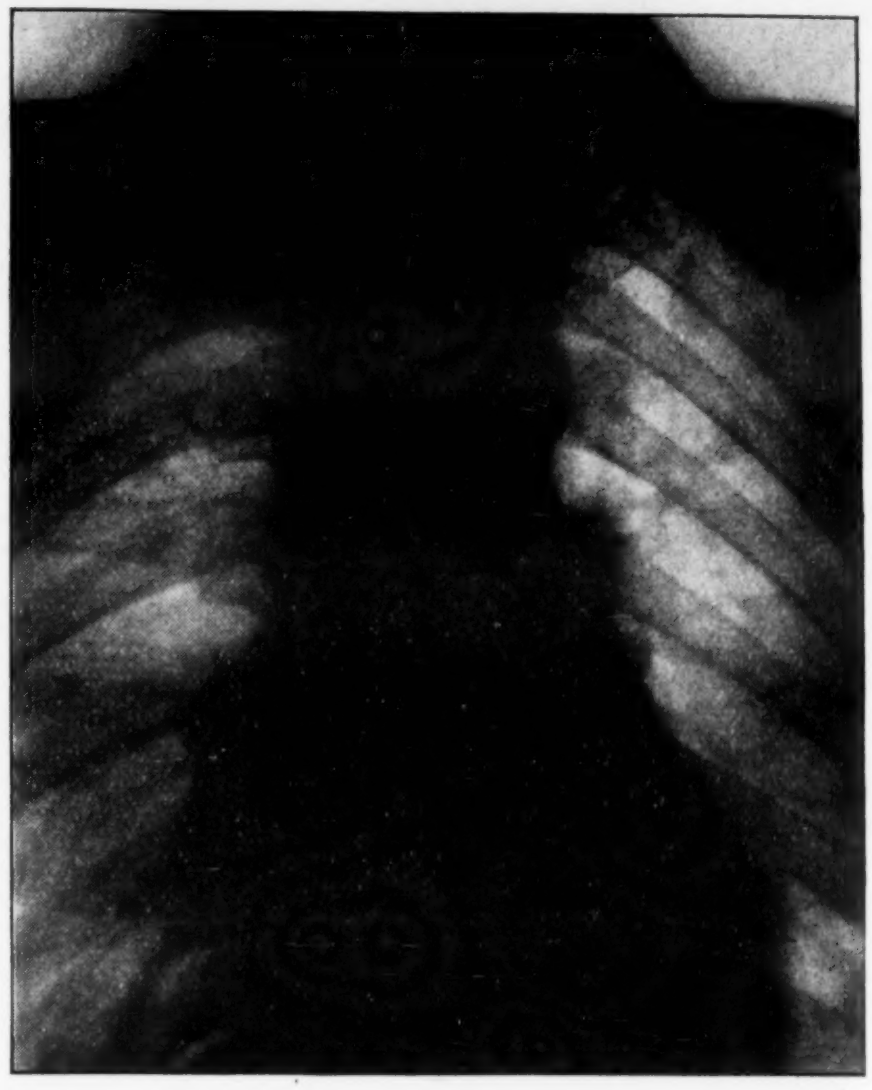

FIG. 3.—Case 7. Medium fibrosis.

FIG. 2.—Case 6. Silicosis with closed tuberculosis.

Mavrogordato (1) quotes from a report by Dr. Moir of the Witwatersrand Mines on a dust called norite, which contained no free silica, but was composed of fine spicular hard minerals, 45 per cent. light felspar, 44 per cent. heavy felspar, and 11 per cent. pyroscene and other dense minerals. No case of definite fibrosis of the silicotic type was detected among workers in this quarry although the dust conditions, especially at the crusher station, could not be worse. In Great Britain it has also been noticed that workers with carborundum—an intensely hard, combined mineral dust—do not suffer unduly from tuberculosis of the lungs.

Silica is generally agreed to be the responsible ingredient of all dusts which so far have been known to cause miners' phthisis (dust fibrosis of the lung). Crystalline silica (SiO_2) is the dioxide of the element silicon, which is widespread and constitutes about 25 per cent. of the earth's surface; combined with aluminium it forms clay. It is present in large quantities in quartz, quartzite, flint, and chert, in sandstones used for building, in ganister used for manufacturing silica bricks, in burrstone used for the manufacture of millstones, and in granite, about one-third of which is quartz. Flint dust such as that used by the potter is pure silica, while gritstone which is used for the manufacture of grindstones contains 96 per cent. silica; silica is absent from or occurs in only very small quantities in coal, cement, clay, emery, and limestone. The percentages of silica present vary in the different stones: Derbyshire gritstone contains 96.4 per cent.; American gritstone, 85.4 per cent.; Aberdeen granite, 29 per cent.; and American granite, from 21 to 30 per cent. It is chemically an extremely insoluble substance (insoluble in all acids except hydrofluoric), possessing acid properties (silicic acid). It is an extremely hard substance, occupying the fourth place in point of hardness according to the generally accepted scale of hardness introduced by Mohs, and it is infusible before the hottest blowpipe flame (13). According to Collis (15), it possesses the property on fracture of breaking up into very fine particles, a number of which are of acicular form; also, when two stones containing it—for example, two quartz pebbles—are rubbed together, a peculiar sulphurous odor is given off. Relying on this indication every intelligent mason will, with no knowledge of the chemical composition, name sandstone after sandstone, and declare them to be injurious to work on. Dundee masons had even told him that Leoch sandstone gave off no such odor, before Dr. Teal had declared that in this rock quartz is in subordinate amount to the other constituents.

Statistical Evidence.—A study of phthisis mortality rates among sandstone, ganister, and granite workers, whether conducted in Great Britain or abroad, bears out the fact that, when pulmonary phthisis is found in excess among such workers, it is always associated with exposure to dust containing crystalline silica. Statistical returns from Derbyshire, Aberdeenshire, Shropshire, and elsewhere in Great Britain bear this out. The workers on sandstone of the Bakewell Registration District of Derbyshire show an excessive mortality from pulmonary tuberculosis (8) as compared with the standardized phthisis death rate of 0.77 for the District, in 1900 to 1910. The phthisis death rate among gritstone workers alone in this area was, in 1900 to 1910, 13.7 per 1,000 employed males. Taking the gritstone and limestone workers (undifferentiated), the rate was 5 per 1,000, contrasting strongly with that for limestone workers alone (1.2), that for coal miners (0.68), and that for agriculturalists (0.66), all working within the same area and living practically under the same home conditions.

The figures for the period 1910 to 1920, as far as I have been able to investigate them from the Death Registers of the district, show a somewhat lower rate, possibly owing to the fact that some of the men were at the war. The male deaths due to phthisis have totaled 31. Of this total, 8 were stone masons; 11 were millstone cutters; 6

were gritstone quarrymen; 3 were grindstone makers; 1 was a limestone quarryman; 1 was a chert quarryman; and 1 was a silica brick maker. The cause of death was certified as follows:

Pulmonary tuberculosis	16
Fibrosis	6
Fibroid phthisis	3
Phthisis	2
Bronchitis	2
Silicosis	1
Pneumokoniosis	1

Two of the three certificates given as fibroid phthisis were further subdivided as follows: A. (i) fibroid phthisis, (ii) non-tuberculous (quarryman's disease); B. (i) emphysema, (ii) asthenia (fibroid phthisis). From the foregoing figures it will be seen that 11, or 35 per cent., of the deaths were certified as phthisis of a presumably non-tuberculous nature, while 2 were certified as phthisis and no attempt was made to define whether the disease was one of a tuberculous or of a non-tuberculous nature.

For the purpose of comparison I have obtained from Dr. Matthew Hay of Aberdeen the figures for the death rate from pulmonary tuberculosis among granite workers in that city for the periods 1900 to 1909, and 1910 to 1919 (Tables 1 and 2). The stone workers of Aberdeen are nearly all engaged in preparing or cutting granite, a stone composed of quartz, felspar, and mica. The silica content of this stone varies in different specimens from 10 to 29 per cent. The silica content of the hardest Aberdeen granite is, therefore, about one-third of that of Derbyshire gritstone. As in Derbyshire, the mortality is greatest among stone masons and stone cutters who largely use pneumatic tools, which generate a great deal of fine dust. The work is done in more or less close sheds, and so fine is the nature of the dust that in a poor light it is scarcely visible to the naked eye. On comparing the figures of Aberdeen with those of Derbyshire (Bakewell Registration District) one notices the similarity which exists—*e.g.*, in 1900 to 1910 the pulmonary tuberculosis death rate per 1,000 employed in Derbyshire was 5; in Aberdeen, 5.7. In Derbyshire the death rate has fallen from 46 in 1900 to 1910 to 31 in 1910 to 1920; in Aberdeen it has fallen from 31 in 1900 to 1909 to

TABLE 1.—MORTALITY FROM PHTHISIS PER 1,000 PERSONS IN THE CITY OF ABERDEEN

Year	Stone Cutters and Masons			Male Population
1910	5.7			1.1
1911	4.8	average		1.4
1912	3.5	5.4		1.0
1913	6.3			1.3
1914	6.4		8.2	1.2
1915	11.2			1.3
1916	13.5			1.1
1917	22.7	13.7		1.3
1918	15.8			1.0
1919	9.6			0.9
1920	4.0			0.8

TABLE 2.—PERCENTAGE OF DEATHS FROM PHTHISIS IN CITY OF ABERDEEN BY OCCUPATION

Occupation	Percentage of All Deaths Due to Phthisis		Average Age at Death from Phthisis	
	1900–1909	1910–1919	1900–1909	1910–1919
Males				
Stone cutters, etc	31	28	43	48
Stone polishers, etc.	14	12	43	48
Joiners, etc.	9	7	36	39
Painters	10	5	30	36
Tailors	12	12	41	41
Bakers	7	6	39	37
Engineers, etc.	13	6	38	45
Printers, etc.	33	16	33	34
Comb makers	19	11	47	47
Carters	9	7	38	48
Laborers	9	10	41	42
Clerks	26	20	30	32
Females				
Dressmakers, etc.	21	17	29	34
Domestic servants	10	8	34	39

28 in 1910 to 1919. It should be noted that the phthisis death rate among agricultural laborers for the same period and district of Derbyshire was 0.72 per 1,000 employed persons. Among carters in Aberdeen it was 1.1 per 1,000. The death rate among wives and widows of stone masons during the same period in Derbyshire was 1.9 per 1,000 deaths; in Aberdeen, 1.8. It will also be noticed from the Aberdeen figures that the death rate among stone masons has increased (owing almost certainly to the increased use of pneumatic tools), from 5.7 per 1,000 in 1900 to 1909 to 8.2 for the decade 1910 to 1920, although during this latter decade there has been a steady decline in the death rate from tuberculosis among the population in general. A similar increase occurred about the same time among American granite cutters.

In other parts of Great Britain workers exposed to silica dust show the same heavy mortality from tuberculosis. The flint knappers of Brandon who are engaged in dressing flint, which is a pure silica of a crypto-crystalline character, have a death rate from phthisis, according to Collis (15), of 41 per cent. as against a rate of 1.6 per cent. for all males over 15 years of age in England and Wales in 1900 to 1902; while the rate among the Brandon rural population was 0.8 (although one might take exception to the smallness of the numbers from which these figures were calculated).

Birmingham (16) gives a description of ganister mining. Ganister is a quartzite rock used in the refractories industry on account of its power to withstand high temperatures without vitrifying. Ganister bricks are used for lining steel furnaces. The silica content of best ganister may be as high as 99 per cent. Several hundred men in Derbyshire are engaged in quarrying and crushing this stone, and of this number about 300 have been examined during 1920, 1921, and 1922. X-ray examinations have been made, revealing a considerable number of cases of dust fibrosis, mostly of the first stage, but some of the second, or "snow storm," stage. The workers are divided into three classes—miners, grinders, and brick makers. The brick makers are the least exposed to dust and, according to Birmingham, have a tuberculosis death rate of 22.2 per 1,000. Miners are more exposed, since they have to enter the mine after "firing," which engenders dense clouds of dust; they have a death rate of 42.3 per 1,000. Grinders, who are greatly exposed to the finest dust arising from the crushing machines, have a death rate of 179.8 per 1,000.

Space prohibits the introduction here of data for many other workers, such as tin miners in Cornwall who suffer similarly from the quartz and quartzite in which the tin lode occurs; masons working sandstone; grinders of articles on sandstone wheels; and makers of millstones. Statistics from abroad are in agreement, whether they refer to gold miners in South Africa or Australia, or to sandstone workers in the United States, Canada, or Germany.

Other points to be taken into consideration in the study of these mortality figures are: (1) the physique of the workers; (2) the home conditions; (3) the presence of infection; and (4) the average age at death.

Physique of the Workers.—Stone workers as a class have a high physical standard, both in Great Britain and in America, even though they are not so selected a group as coal miners. Hoffman (13) has shown that the relative weight of the granite workers of Barre,

Vermont, is 2.41 pounds per inch of height; coal miners have a relative weight of 2.29 pounds, and all other occupied males 2.30 pounds, the average medico-actuarial standard being 2.28 pounds. Stone workers therefore are not weaklings.

Home Conditions.—The home conditions among stone workers, both in Great Britain and in America, are above the average compared with those of workers in other occupations. Dr. Barwise (8) states that both as to housing and as to working conditions and wages they are in a favored position compared with the agricultural laborers whose life is hard, with exposure to climatic conditions, and whose standard of living is poor; yet the phthisis death rate among this class is 0.66 per 1,000 as against 5 per 1,000 for stone workers. Regarding overcrowding, I possess no figures for Derbyshire, although from personal visitation I know that there is less overcrowding among the families of stone workers who occupy, as a rule, better and larger houses than many workers at other occupations. Hoffman (13) states that the average number of persons to a room among the granite workers of Barre, Vermont, is 0.87, while among Brooklyn working class families it is 1.49 or, according to the English standard of more than 2 persons in a room, it is 1.3 per cent. for granite workers as against 24.2 per cent. for Brooklyn workingmen's families.

Presence of Infection.—The existence of a family history of pulmonary tuberculosis among granite workers' families was investigated by Hoffman (13) who found that "of a total of 1,869 granite workers interviewed, 312 gave positive tuberculosis histories in their families." The wives and families of stone cutters have a smaller phthisis death rate than the wives and families of other workers. In the Bakewell Registration District of Derbyshire, for instance, among the wives and families of stone workers the percentage of all deaths due to phthisis is 13.1 as against 20.8 among the wives and families of agricultural laborers. The death rates per 1,000 among wives and widows of stone masons in Aberdeen and in Derbyshire are 1.8 and 1.9, respectively. These figures, which are in close agreement with those of Dr. Hoffman for American granite workers, show that there is no increased infectivity from pulmonary tuberculosis among the families of stone workers, although theoretically the disease should be met with in practically the same proportions among the different members of stone workers' families as among the stone workers themselves, on the assumption that through infection the disease is spread from one diseased adult to another.

Average Age at Death.—The average age at death of stone workers dying from pulmonary phthisis is high, as is shown by the following comparative figures.

Group	Average Age at Death	Period
Derbyshire	54.0	1901-1910
gritstone masons (8)	46.5	1910-1920
Aberdeen	43.0	1900-1909
granite workers (17)	48.0	1910-1919
Cornish rock drillmen (14)	37.2	1904
Cornish tin miners, non-drillmen (14)	53.0	1904
Staffordshire potters (14)	46.5	1902
Swadlincote, Derbyshire, potters	45.0	1916-1921
Barre, Vt., granite cutters (13)	37.4	1910-1920
Rand gold miners (14)	35.5	1903

The point is also well brought out by the following data for the city of Aberdeen, 1900 to 1910, published by Dr. Hay (17).

Population at Risk	Deaths from Phthisis at Ages over 35	
	Number	Per 1,000
1,750 stone cutters	22	12.6
3,600 laborers	14	3.9
9,235 other males	14	1.5

Collis (18) points out an interesting fact regarding coal miners in this connection—namely, that those working at the coal face where they are most exposed to stone dust in cutting through coal seams mixed with stone strata, have an average age at death from phthisis of over 45 years.

Beattie (19) also points out that in Sheffield the maximum death rate from phthisis among steel grinders occurs between the ages of 50 and 60; and even at 70 the death rate from phthisis is higher than it is between the ages of 20 and 30. Compared with other non-dusty occupations in which the average age at death from phthisis is 38, these figures show that the average age at death from phthisis among stone workers is decidedly high.

Fibroid Phthisis a Distinct Entity

Statistics based on deaths from phthisis do not give any clue to the number of deaths due to dust fibrosis in which tuberculosis has played no part. In regard to this lack of information, Landis (20) has written: "It is not always possible, even with the X-rays, to determine whether the case is one of pneumokoniosis alone or whether there is an associated tuberculous lesion. The examination of the sputum then is our chief reliance in detecting those who have and those who have not tuberculosis. Neglect of this precaution has led to the inclusion in tuberculosis statistics of a fairly high percentage of cases in which extensive fibrosis of the lungs, the result of a pneumokoniosis, is the actual trouble." The result of this neglect is well shown in my own figures for the Derbyshire gritstone area during the decade 1910 to 1920, and from study of the death certificates already detailed.

A tendency exists to consider that all persons with fibroid phthisis must sooner or later contract tuberculosis. Probably it is hardly justified; Hoffman (13) has even written, "There are abundant reasons for believing that the disease certified as pulmonary tuberculosis among granite workers is often not a true form of tuberculosis, but strictly speaking a pneumonoconiosis, or in other words a dust phthisis of non-tuberculous origin, though possibly in the terminal stages complicated by a superinduced tuberculosis."

Tatham also (see Oliver (21)), a number of years ago, wrote of the so-called potters' phthisis: "It is certain that much of the so-called potters' phthisis ought properly to be termed cirrhosis of the lung. Deaths from this affection should not be included under the head of phthisis, which term is now restricted . . . . to the tubercular malady of that name." While Peacock (22), as far back as 1864, wrote: "The form of the disease in which there is local consolidation in some portions of the lungs bears a close general resemblance to true consumption and especially where, as often happens, the voice is husky and the patient expectorates blood. There are, however, features by which it is sufficiently distinguished from that disease; it usually occurs in persons who do not present any hereditary predisposition to phthisis; it commences at a later period of life; it is also much slower and less active in its progress. The quickness of the pulse, the rapid emaciation and night sweats so characteristic of true phthisis are generally absent, and there is rarely

diarrhoea.'' This contrast between the extensive pulmonary lesions and the absence of marked constitutional symptoms is the distinguishing feature of general fibrosis of the lungs due to dust inhalation. The Report of the British Departmental Committee on Compensation for Industrial Diseases (23) expresses it as follows: ''Herein fibroid phthisis presents a well-marked difference from pulmonary tuberculosis and even if the disease becomes complicated with tuberculosis the rate of progress may be determined rather by the character of the primary than the secondary disease, though usually the supervention of tuberculosis hastens the sufferers into a more rapid consumption.''

The question arises as to what relationship, if any, exists between a fibroid silicosis of the lung and pulmonary tuberculosis. There is much debatable ground as to whether fibrosis predisposes to tuberculosis, or whether fibrosis is protective against tuberculosis, or whether silicotic fibrosis is peculiar in predisposing to tuberculosis. Detailed clinical and postmortem work with appeal to guinea-pig inoculations is needed to advance knowledge. Different authorities have put forward different views; for the present, however, it is sufficient to state the facts and to disregard the theories while pointing to the need for further investigation.

Toxic Character of Silica.—One fact in particular has emerged from recent research: The idea that dusts act as mechanical irritants owing to their sharpness and hardness has been abandoned. Mavrogordato (1) has told how dust particles are taken up and dealt with by the macrophage cells which early exhibit a ''pleural drift'' and flock together to form pleural pseudo-tubercles, or dust nodules, thereafter forming free pseudo-tubercles in the lung tissue and, lastly, fibrosis of the pulmonary lymphatics, which they block. The cells flock together because they appear to be protected both from autolysis and from digestion in the lymph; but this only holds true of silica dust cells and does not occur with other dusts, the cells laden with which do not block the lymphatics but are dissolved leaving the dust free to be carried away. This preservation of silica-laden cells is, according to Mavrogordato, due to the fact that the fine particles of silica are slightly soluble in the alkaline tissue juices. There is a drift of alkaline silica through the invaded cells, the principle being similar to that of the preservation of eggs by water-glass. Tissue death is associated with acid autolysis, and the alkaline silicate is precipitated as silicic acid, thus perhaps preserving the cells as mummies by impregnation.

This observer describes three stages in the occurrence of fibrosis: (1) the provocation of dust cells; (2) the aggregation of these cells and their accumulation in the lymphatics; and (3) the fibrosis of the obstructed lymphatics.

Research carried out by Gye and Kettle (24) throws light upon the action of silica upon cell life. They base their work on the facts: (1) that colloidal silica is a cell poison; (2) that colloidal is the most easily formed soluble salt of silica, the circulation of silica in nature depending upon this; and (3) that living matter (soil bacteria) is able to break up mineral silicates with formation of soluble silica. Colloids are substances possessing the following characteristics (25): (1) they will not pass the membrane of a dialyzer: (2)

their solutions are opalescent; (3) they crystallize with difficulty. Inorganic substances—*e.g.*, several metals and compounds, such as silicic acid—may also assume a colloidal condition. These are in an unstable condition physically which confers upon them their power to act as catalysts. They are not true solutions, but suspensions of minute particles which, though invisible even to the highest powers of the microscope, nevertheless scatter light.

Gye and Kettle (24) made a series of experiments on mice, animals which have a high degree of immunity to tuberculosis, by injecting them with a suspension of either silica dust or colloidal silica. (1) The resulting lesion consisted of a central acellular area of coagulative necrosis surrounded by a zone of leukocytes, and outside of this a secondary area of necrosis surrounded by a granulative tissue. In the course of time the necrotic tissue was gradually absorbed and replaced by macrophages, and the final picture was that of an organizing inflammatory fibrosis. (2) When tubercle bacilli were injected along with the silica solution, active proliferation of the bacilli could soon be seen occurring in the central necrotic coagulum; but whether this coagulum acts merely as a culture medium in which the bacilli are protected from destruction by the body cells and fluids, or whether the silica actually stimulates the proliferation of the bacilli is still uncertain. (3) Silica solution circulating in the blood stream of rabbits (which were injected intravenously with the solution) did not materially influence a generalized tuberculosis already induced. Apparently only where the poison is sufficiently concentrated to form local areas of tissue destruction is the growth of the bacillus promoted.

Granted, then, that the production of fibrosis is due in part at least to the chemical action of silica particles and that the fibrosis thus produced predisposes to tuberculosis, the question arises as to whether the colloidal change of the cell protoplasm facilitates the growth of bacteria.

The experiments just referred to may seem to offer an explanation as to why tuberculous processes seem to be accelerated in the silicotic lung; to my mind, however, no satisfactory evidence has yet been produced to show that dust fibrosis in itself specially favors tuberculous infection. All writers speak of the infection as a terminal one, although on what grounds they do so, other than the fact that dust workers often die, in the end, of pulmonary tuberculosis, is to my mind obscure. We know that the average age at death from pulmonary tuberculosis among these workers is higher than usual and this, as Dr. Hay says, means that either the disease began late or has lasted long. In my opinion the latter is the correct view.

Investigation shows that tubercle bacilli and dust particles tend to become located in the same anatomical situation, and the presumption is that the same mechanical and physiological forces which tend to place the one foreign body operate in the same manner toward localizing the other. Hence, since infected dust particles are the primary cause of the formation of fibrous nodules, just as are sterile dust particles, the tubercle bacilli should be found in the same situation; and this is what we do find—*i.e.*, they are located in the center of the oldest part of the nodule where necrotic changes first take place, and this occurs in silicotic lungs which do not show signs of typical tuberculous processes elsewhere. The question naturally arises: How and when did the

bacilli get there? May they not have got there quite early and been kept in captivity, shut off by fibrous tissue arranged (as it is in these nodules) in concentric rings? They would find in the central necrotic coagulum, which Gye and Kettle describe, a culture medium in which they are protected from destruction by the body cells and fluids. Possibly years afterwards the progressive degeneration of the lung tissue more or less rapidly releases them, and floods them into a lung which has not had time for the proper revascularization of its tissues and consequently has not developed the normal defences; now they produce an acutely infective process which progresses rapidly to a fatal termination, producing apparently all signs of a terminal infection. This hypothesis I wish to put forward tentatively, but with the hope that it is as worthy of credence and further consideration as are any of those which I have recently seen promulgated. Here interest attaches to the clinical history of a patient suffering from silicosis, given by Dr. Mavrogordato (1). The record shows that this Witwatersrand miner first displayed signs of chest trouble nearly thirty years ago, and yet in 1912, except for shortness of breath, he was still in fair general health and physical condition, although his case was classified as closed tuberculosis and silicosis; and Mavrogordato adds: "This case shows that well-marked simple silicosis need not progress and that tuberculosis can remain 'closed' for years in spite of it."

Here then, so far as present knowledge goes, the matter must be allowed to rest until it is cleared up more conclusively. This can only be done by careful experimental investigation and clinical observation, in which the examination of the sputum, the X-ray findings, and the records of autopsies should be carefully chronicled. Whatever controversies this subject may give rise to—and they are many, for the subject, as Professor Beattie says, "bristles with difficulties"—there yet remains one common ground of agreement, namely, that taking the length of the occupational life in these cases, the average age at death, the repeated hemorrhages, the intense dyspnea as a cardinal symptom, the maintenance of weight, the absence of toxic symptoms, the radiographic demonstration of local lesions in the lung out of all proportion to the symptomatology, we have before us a clinical condition which we now know and recognize as a chronic fibroid disease of the lung due to the inhalation of dust—a pneumokoniosis—a condition, clinically, and pathologically distinct from the disease known as pulmonary tuberculosis, caused by the ravages of the bacillus of Koch.

Tuberculosis as a Complication

Other writers have discussed at length the effect of tuberculous infection upon cases of dust fibrosis. The clinical features change and the cases come to agree more closely with ordinary pulmonary tuberculosis. The chief points in differential diagnosis are:

Simple Silicosis	*Pulmonary Tuberculosis*
Fever absent	Fever present
Pulse normal	Pulse rapid
Night sweats absent	Night sweats present
No loss of weight	Loss of weight
Malaise absent	Malaise present
Sputum negative for tuberculosis	Sputum positive for tuberculosis
Dyspnea marked	Dyspnea only marked in advanced cases
Toxemia absent	Toxemia present
Radiographic Appearances	
Particulate (mottling)	Reticulate (branching)
Blood Count	
Hemoglobin normal	Hemoglobin decreased
Red blood corpuscles increased	Red blood corpuscles decreased
Leukocytes normal	Leukocytes increased
Polymorphonuclears normal	Polymorphonuclears in excess

Cases Illustrating Silicosis plus Tuberculosis (Infected Silicosis)

CASE 8.—A. H., aged 54, worked as a sanitary potter for thirty years. He was admitted to my care in May, 1919. His weight was 8 stones 10 pounds; there were signs of marked fibrosis in both lungs, the left lung in this case being the more severely affected. There was much secondary bronchitis and dyspnea on exertion; sputum was abundant, but was negative for tuberculosis. He was asked to give up his trade, which he did, and obtained work in the open air. On October 28, 1919, he was given a graduated tuberculin test which resulted in a reaction to 100°F. on reaching a dilution of 0.0005 O. T. He refused sanatorium treatment and was not seen until a year afterwards, when he had lost 9 pounds in weight, and his sputum exhibited tubercle bacilli on examination. Unfortunately the further history was lost as the patient removed from the district. No radiogram was obtained.

CASE 9.—A. T., aged 49, had been employed as a sanitary potter for thirty years. He was admitted to the dispensary under my care on June 21, 1922, with clinical signs of bilateral phthisis more advanced on the right side. There was a small cavity in the right apex. His temperature ran from 97.4 in the morning to 99.4 in the evening; his pulse was 84. His weight was 8 stones 8 pounds. There was considerable toxemia present and he gave a history of night sweats, severe dyspnea, and a racking cough. He was sent to the sanatorium where he died suddenly from a severe hemorrhage, three months after admission. His sputum throughout was positive for tuberculosis (swarming with bacilli). A radiogram showed a silicotic lung of the advanced type, complicated with tuberculosis, and a good deal of compensatory emphysema, especially on the right side.

CASE 10.—S. S., aged 36, worked as a gritstone mason for fourteen years (gritstone has a silica content of 96.4 per cent.). He was admitted to the dispensary in October, 1920; his weight, on admission, was 11 stones, but he had done no stone cutting since 1916, as he was absent at the war. He had complained of cough and shortness of breath for some years. The symptoms were: cough, pain in the chest, dyspnea and slight hemorrhages, with some loss of voice. The results of the sputum examinations made after his admission to the sanatorium on November 17, 1920, were as follows:

Nov. 19, 1920	Negative
Nov. 30, 1920	Negative
Dec. 12, 1920	*Positive*
Dec. 29, 1920	Negative
Jan. 3, 1921	Negative
Feb. 6, 1921	*Positive*

A radiogram disclosed nodules more densely distributed at the apex of the lobe than at the base, and exhibited the particulate character of the mottling so characteristic of cases of silicotic fibrosis (see Fig. 4). The particulate shadows are clearly defined, with dense centers and more woolly edges. This character of shadow is seldom seen in cases of purely tuberculous phthisis except in cases of long standing, in which calcification of the tubercles has begun, and even then the distribution is different; the shadow is not so diffusely scattered in pulmonary tuberculosis as in silicosis and is apt to be unilateral and even unilobular in distribution.

The clinical findings were those of a marked fibrosis with consonant crepitations at the right apex and some laryngeal inflammation with swelling of the interarytenoid membrane. On December 28, 1920, the patient had a short pyrexial attack and had to be confined to his bed. On January 17, 1921, he coughed up some small black-colored calculi. On February 8, he was delirious and had to be kept quiet by morphia injections. His pulse was very rapid. He grew steadily worse and died at 3.20 A.M. The following is the autopsy report:

The right lung showed recent coagulated fibrinous exudate over the pleura of the middle lobe, which was adherent to the chest wall. The whole upper lobe was firmly adherent to the chest wall and could only be separated by tearing the lung. This lobe was hard and nodular, one section consisting of a mass of black gritty nodules varying in size from that of a pin head to that of a small pea. The lung tissue was honeycombed with small cavities and was very fibrotic. No normal alveolar tissue was seen. The lower lobe was studded with similar gritty nodules, but not so thickly. The nodules were much more densely distributed in the apex of the lobe than at the base. Very little tuberculous disease could be found in this and the middle lobe except a few caseous patches here and there in the cortex. (See Fig. 5.)

The left lung showed a similar condition of silicosis, denser at the two apices than at the base. The apex was firmly adherent to the chest wall, but the pleura could be peeled off

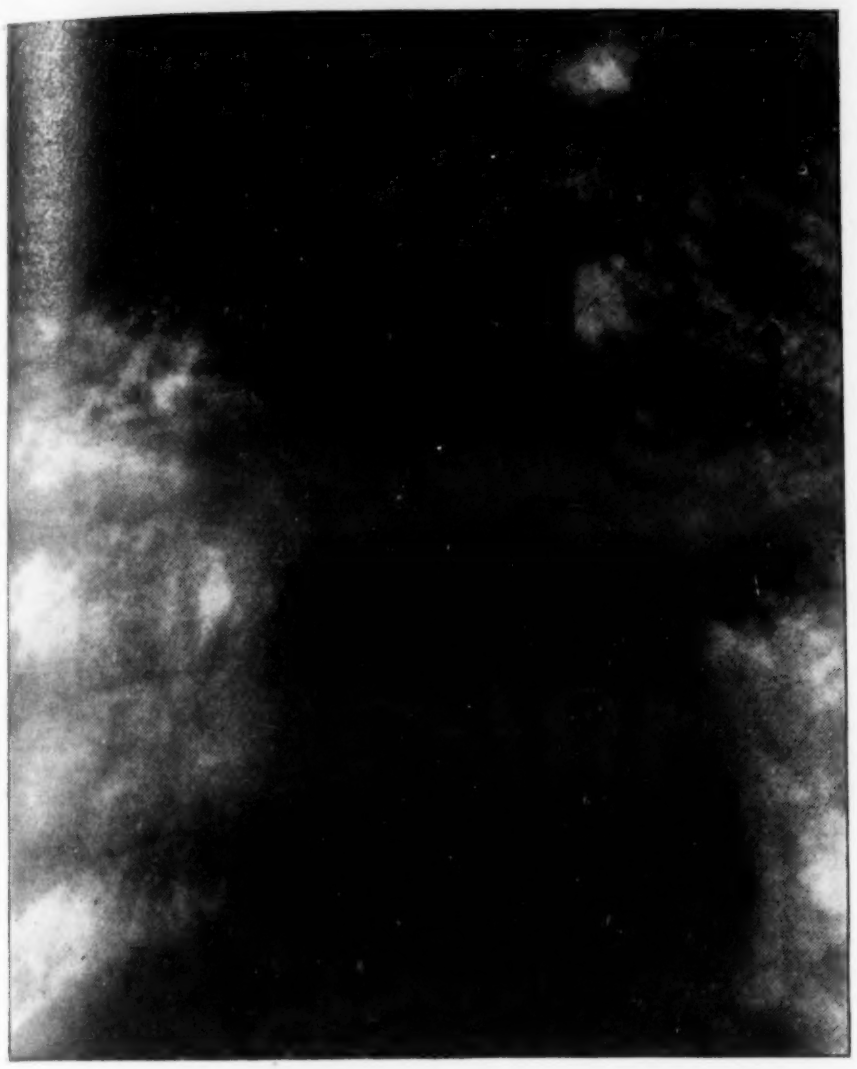

FIG. 4.—Case 10. Open tuberculous silicosis.

FIG. 5.—Section through lungs of Case 10.

without tearing. The pleura over the posterior part of the left base was adherent.

The tracheal, tracheobronchial, and bronchial glands were all large and black, but very little calcified material was found. Numerous miliary tubercles were seen distributed throughout. The heart and arteries were normal, and the spleen only slightly enlarged. The skull was not opened.

PROPHYLAXIS

1. The formation of dust should as far as possible be prevented. Much has been done for this purpose in South African mines with good results. The methods used are applicable to ganister and metalliferous mining in Great Britain, to some quarrying processes, and to the crushing of silica materials. Other processes, such as grinding on sandstone wheels and stone masons' work, require new methods. Masons' work should be done in the open air so that the dust may be rapidly diluted and blown away; closed-in sheds should be prohibited. Sandstone wheels should be discarded in favor of composition wheels which give off far less dust and need not contain silica.

2. Inhalation of dust when generated should be avoided. This purpose is difficult to accomplish. Various respirators have been advocated from time to time which, if worn by the operator, would protect him from excessive dust inhalation. In practice, however, they have all proved failures, for the simple reason that the dust particles which do harm are so small that they can only be arrested by gauze with a mesh so fine as to offer an impossible barrier to the wearers' powers of respiration.

3. The careful selection of operatives should be enforced. As long ago as 1862 Greenhow (26) pointed out that his observations led him to believe that the development of tuberculosis in persons affected with silicosis was determined largely by predisposition and family history. It would therefore be advisable that employers should not engage men who come from phthisical families, and that those workers who reside in houses which become infected

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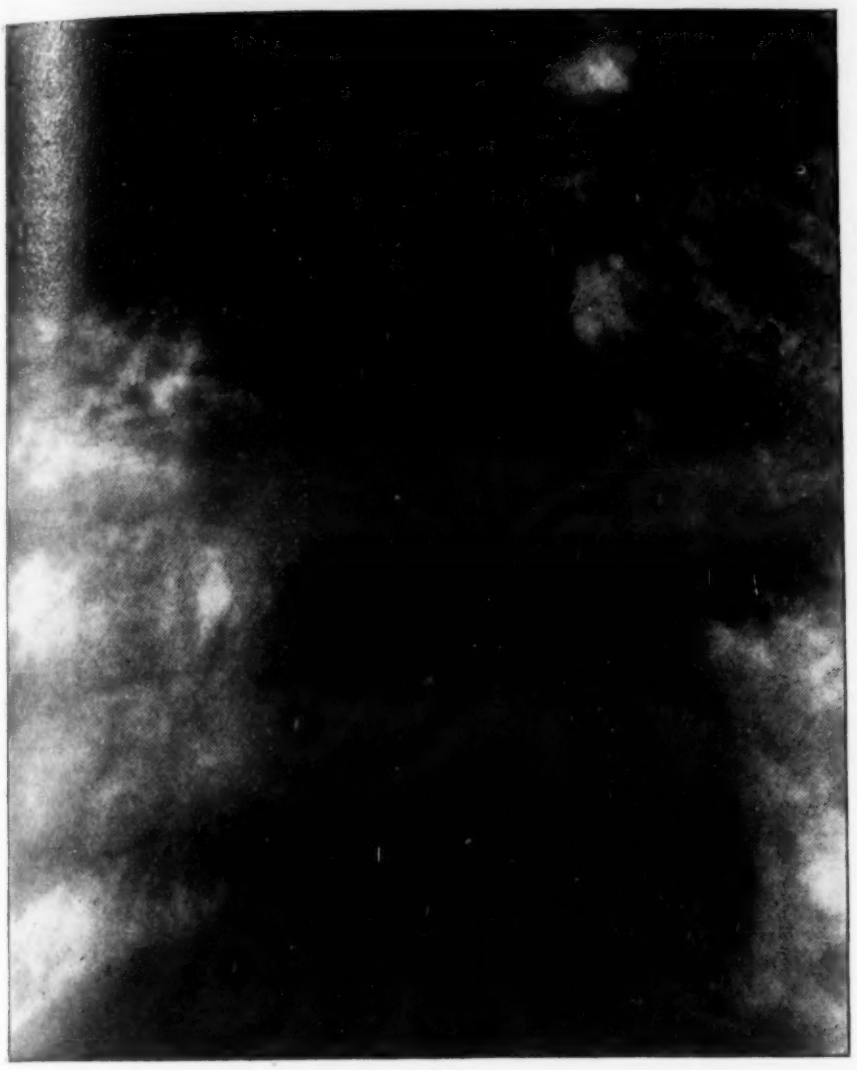

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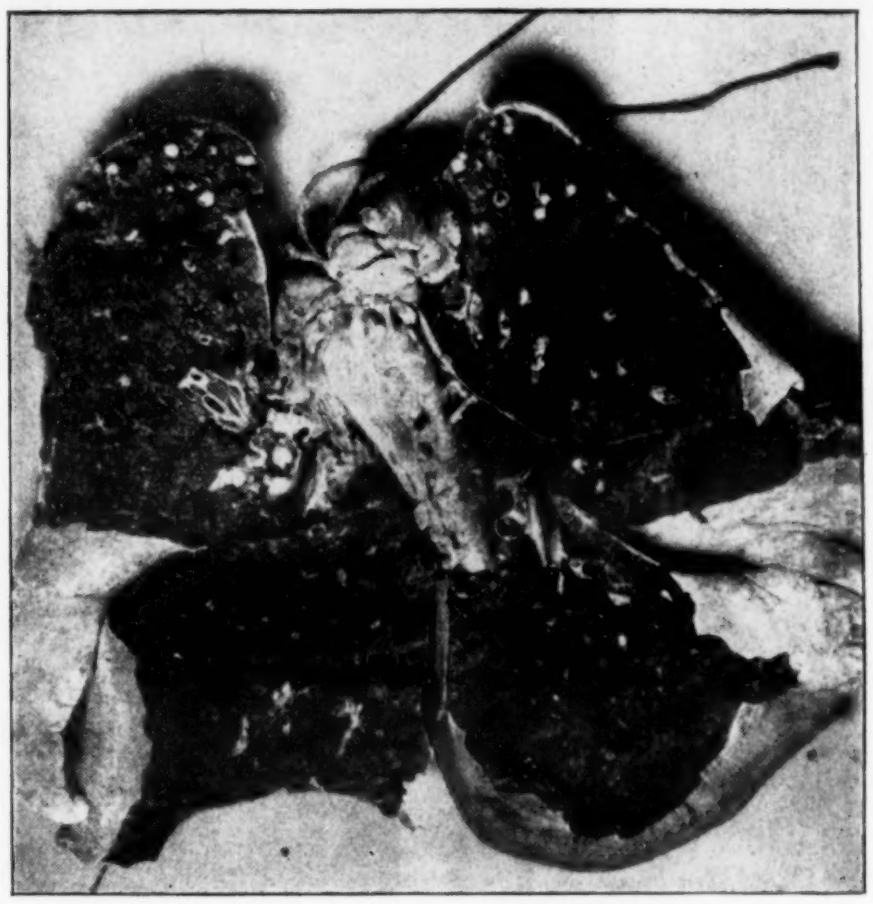

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3. The careful selection of operatives should be enforced. As long ago as 1862 Greenhow (26) pointed out that his observations led him to believe that the development of tuberculosis in persons affected with silicosis was determined largely by predisposition and family history. It would therefore be advisable that employers should not engage men who come from phthisical families, and that those workers who reside in houses which become infected

should be made to seek new quarters or should be dismissed from the trade.

4. There is necessity for a systematic examination of all workers in trades dealing with silica dust, including X-ray examination and the routine examination of sputa for tubercle bacilli. Such an examination is now provided for under the Refractories Industry Scheme of the Silicosis Act of 1918 which requires:

(a) An annual examination and record of the physical condition of all workers of refractory materials containing not less than 80 per cent. silica.

(b) The suspension from employment of all persons found to be suffering from such a degree of silicosis or silicosis plus tuberculosis as to make it hazardous for them to continue their employment, or to accelerate materially the progress of their disease.

(c) The provision of compensation for all workmen thus suspended or excluded.

The act is a good one, but it has not been applied far enough. As it stands at present it covers only ganister miners and refractory brick makers, leaving out granite workers, gritstone workers, and potters. Also, the percentage of silica, fixed for trade reasons in the Refractories Industry Scheme at 80 per cent., is much too high, as granite workers suffer greatly from silicosis and yet the content of silica in Scottish granite is under 30 per cent.

Further, it is important to remove at once and for all time all workers who are found, on examination, to show a definite degree of fibrosis of the lungs. These persons, provided they are not infected with tuberculosis, when removed to a non-dusty occupation usually make a complete recovery. As Mavrogordato (1) says, "there is no reason why simple silicosis should progress if the subject is no longer exposed to silica dust. The damaging element—dust—does not multiply on its own account in the lung, and if the supply be cut off the disease should be arrested. On the other hand there is no reason why an infective silicosis should remain stationary, the damaging element—micro-organisms—will multiply on their own account." In several cases of my own both among potters and among gritstone workers the removal from their dusty employment to an open-air trade has given the sufferers relief, and their working capacity for the future has not been seriously reduced.

Summary

1. Most inhaled dust is expelled from the air passages; but some minute particles pass into the alveoli and are carried thence into the lung tissue.

2. Dust particles in the lung tissue undergo a pleural drift; where they come to rest they cause inflammatory changes which result in the formation of pseudo-tubercles, the beginning of fibrosis.

3. All dusts are not equally harmful —*e.g.*, coal is possibly beneficial, lime is neutral, but silica is particularly injurious.

4. Silica, owing to the formation of pulmonary fibrosis, causes a train of symptoms which can be distinguished clinically from those of pulmonary tuberculosis. For this purpose radiography is of great use.

5. The evidence of the injurious character of silica dust is drawn chiefly from industrial mortality statistics in which all forms of phthisis are taken together. Statistical evidence from all parts of the world agree on this point; and there is no evidence that any other factor beyond the inhalation of silica is the responsible agent.

6. Careful consideration of the disease entity, pulmonary silicosis, of its slow development and clinical manifestations, and of its non-infective character, points to the conclusion that more persons than it is generally thought die without becoming tuberculous.

7. Consideration, in addition, of the reaction of living tissue to colloidal silica leads to the theory being put forward—namely, that when tuberculosis is manifested, the infection is not necessarily new, but may have occurred when the dust particles were originally inhaled and have remained latent within the necrotic center of the pseudo-tubercles until a breakdown of the surrounding scar tissue releases a massive infection upon tissues of low vitality.

8. The low infectivity of cases of pulmonary fibrosis is probably due (*a*) to the fact that many cases are never tuberculous at all, and (*b*) to the rapid termination of open infective cases, leaving but a short period for infecting contacts.

9. The terminology appearing today on death certificates is faulty; the cases should be described as (*a*) pulmonary fibrosis, and (*b*) tuberculosis (if present). The term "phthisis" is unsatisfactory and should be expunged.

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BOOKS RECEIVED

Books received are acknowledged in this column, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers and as space permits.

CHEMISTRY INORGANIC AND ORGANIC: WITH EXPERIMENTS. By *Charles Loudon Bloxam.* Eleventh Edition Revised by *Arthur G. Bloxam*, F.I.C., Consulting Chemist and Chartered Patent Agent, and *S. Judd Lewis*, D.Sc., F.I.C., Consulting and Analytical Chemist. Cloth. Pp. 832 with index and 310 illustrations. Philadelphia: P. Blakiston's Son & Co., 1923.

COLONIC AND DUODENAL LAVAGE. WITH A SUGGESTED IMPROVEMENT IN THE PLOMBIERES TREATMENT. By *Capt. J. T. Ainslie Walker*, R.A.M.C. (T.F.); Fellow of the Royal Society of Medicine; Fellow of the Institute of Chemistry; Fellow of the Chemical Society. Paper. Pp. 12 with illustrations. London: H. K. Lewis & Co., Ltd., 1923.

MEDICINE MONOGRAPHS: CYANOSIS: By *Christen Lundsgaard* and *Donald D. Van Slyke.* From the Rockefeller Institute for Medical Research. Cloth. Pp. 80. Baltimore: Williams & Wilkins Company, 1923.

PRACTICAL BACTERIOLOGY, BLOOD WORK AND ANIMAL PARASITOLOGY, INCLUDING BACTERIOLOGICAL KEYS, ZOÖLOGICAL TABLES AND EXPLANATORY CLINICAL NOTES. By *E. R. Stitt*, A.B., Ph.G., Sc.D., LL.D., Rear Admiral, Medical Corps, and Surgeon General, U. S. Navy; Graduate, London School of Tropical Medicine; Member National Board of Medical Examiners; Member Federal Board of Hospitalization; Member Advisory Board, Hygienic Laboratory. Formerly: Commanding Officer and Head of Department of Tropical Medicine, U. S. Naval Medical School; Professor of Tropical Medicine, Georgetown University; Professor of Tropical Medicine, George Washington University; Lecturer in Tropical Medicine, Jefferson Medical College; Associate Professor of Medical Zoölogy, University of the Philippines. Seventh edition, revised and enlarged. Cloth. Pp. 766, with appendix, index, and illustrations. Philadelphia: P. Blakiston's Son & Co., 1923.

Fifty-Second Annual Meeting of THE AMERICAN PUBLIC HEALTH ASSOCIATION Boston, Mass. October 8-11, 1923

Tentative Program

INDUSTRIAL HYGIENE SECTION

SESSION I *

Reading of Minutes of Previous Meeting.

Election of Nominating Committee.

Address of Chairman.

THE STATUS OF THE PROBLEM OF RESUSCITATION IN CASES OF RESPIRATORY FAILURE. *Cecil K. Drinker, M.D.,* Laboratory of Applied Physiology, Harvard Medical School, Boston, Mass.

STANDARDS FOR PROCEDURES IN LEAD POISONING. *Joseph C. Aub, M.D.,* Laboratory of Applied Physiology, Harvard Medical School, Boston, Mass.

Discussion led by Dr. Fairhall, Harvard Medical School, and Miss Minot, Harvard Medical School.

THE DISEASES OF PRESSERS AND TAILORS, BASED ON SUPERVISION OF SIX THOUSAND WORKERS FOR TEN YEARS. *George M. Price, M.D.,* Director of Union Health Center, New York City.

Discussion led by J. W. Schereschewsky, M.D.

PHYSIOLOGICAL STUDIES IN CONNECTION WITH VENTILATION. *Philip Drinker, B.S., Ch.E.,* School of Public Health, Harvard University, Boston, Mass.

THE USE OF ELECTRIC PRECIPITATION IN THE ESTIMATION AND MICROSCOPIC STUDY OF ATMOSPHERIC DUST, FUMES, AND SMOKE. *Philip Drinker, B.S., Ch.E.,* School of Public Health, Harvard University, Boston, Mass.

Discussion led by Mr. Leonard Greenburg, U. S. Public Health Service, New Haven, Conn.

*This session will probably be held in the School of Public Health of Harvard University, on account of the two demonstrations by Mr. Drinker.

SESSION II

Business Meeting, Industrial Hygiene Section.

THE DIAGNOSTIC CLINIC OF THE HENRY PHIPPS INSTITUTE, WITH ANALYSIS OF CASES. *Frank A. Craig, M.D.,* Henry Phipps Institute, Philadelphia, Pa. (Tentative.)

STANDARDS OF TEN THOUSAND PHYSICAL EXAMINATIONS OF INDUSTRIAL WORKERS. *L. R. Thompson, M.D.,* Surgeon in Charge, Industrial Hygiene Bureau, U. S. Public Health Service, Washington, D. C.

Report of Nominating Committee.

Election of Section Officers.

OCCUPATIONAL DISEASE COMPENSATION. *John B. Andrews, Ph.D.,* Secretary, American Association for Labor Legislation, New York City.

Discussion led by F. L. Rector, M.D., Secretary, Conference Board of Physicians in Industry, Boston, Mass.; and E. R. Hayhurst, M.D., Ph.D., Professor of Hygiene, Ohio State University; Consultant, State Department of Health, Columbus, Ohio.

THE ECONOMICS OF INDUSTRIAL HEALTH SERVICES. *Bernard L. Wyatt, M.D.,* Director Health Service, Laurentide Co., Grand'mere, Quebec.

It is also probable that a speaker of international reputation in this field will be secured to speak at one of the General Sessions on the subject of "The Economics of Industrial Hygiene," having in mind the shortage of labor at the present period, the restrictions on immigration, etc.

Emery R. Hayhurst, M.D.
Chairman, Program Committee

J. I. H.
Oct., 1923.